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GEOLOGICAL SURVEY

OF

ALABAMA.

REPORT OF PROGRESS FOR 1875.

BY
EUGENE A. SMITH, PH. D.,
STATE GEOLOGIST.

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WITH THE COMPLIMENTS OF
EUGENE A. SMITH,
State Geologist,
University of Alabama.

Exchanges are respectfully solicited.

To His Excellency,

GEORGE S. HOUSTON,

Governor of Alabama:

SIR—The Report of Progress of the Geological Survey, for the year 1875, is herewith respectfully submitted.

I have the honor to be, sir,

Your obedient servant,

EUGENE A. SMITH,

State Geologist.

UNIVERSITY OF ALABAMA,

December 31, 1875.

LIST OF ERRATA.

On page 9, near the middle, for *Arcadian*, read *Acadian*.

On page 24, and wherever it occurs in the sequel, the word *chazy* should be printed *Chazy*, with a capital.

On page 26, near middle, for *Willis'*, read *Wills'*.

On page 27, 13th line from top, for *Keokuss*, read *Keokuk*.

On page 80, 8th line from top, for *omnipotent*, read *omnipresent*.

On page 91, 6th line from top, for *Ashley*, read *Ashby*.

On page 113, 5th line from top, for *limonite*, read *limestone*.

On page 129, near middle, for *fellspar*, read *feldspar*.

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PREFACE.

In continuation of the plan adopted at the beginning of the survey, the work of the past season has been devoted chiefly to the examination of Silurian formations, and of that belt of Silurian rocks, particularly, which lies next adjacent to the Metamorphic rocks, which formed the subject of the last report.

In carrying out the work, the beds of limonite or brown iron ore, which occupy so considerable a part of the surface covered by the lower Silurian formations, have been examined wherever it was possible to do so; but to do complete justice to the ore banks of this region, a detailed survey of months duration would be necessary.

It was thought best to carry the survey a little more into details than was the case last year, and this will account for the comparatively small area gone over. It may be remarked, however, that the tracing out, and mapping down of the formations in those regions where the strata are highly inclined, require much more time and careful exploration, than where they are approximately horizontal; for where the broken edges of a series of tilted rocks form an outcrop, to map this outcrop, and consequently the occurrence of the formation accurately, it is necessary to trace out the entire line of outcrop, and since in comparatively small space, a number of different geological formations are brought up to the surface, it is easily seen how much field work the thorough examination of such an area necessitates.

Maps of Shelby, Talladega, and Calhoun counties, colored to represent the geological formations have been prepared. The printing of these maps is not provided for, and it has been impossible for me to present them with this report. I trust, however, that future reports will not be marred by this deficiency.

It is with pleasure that I acknowledge here the valuable aid which I have had, in the prosecution of the field work, from PROF. JAMES M. SAFFORD'S published volume on the

Geology of Tennessee. The Tennessee sub-divisions have been generally followed in this report.

My thanks are due to the young men who took part in the field work; with their assistance I have been enabled to accomplish more than I could have done single handed. They are Prof. R. B. Fulton of Oxford, Miss., Prof. T. T. Mitchell of Greensboro, Mr. F. W. Wilkinson of Montevallo, Mr. Thos. W. Clark of the University of Alabama, Mr. John A. Ratchford and Mr. E. C. Rivers of Auburn College.

To Judge Thos. A. Walker of Jacksonville, to Col. J. Newton Smith of Bibb county, to Col. E. R. Smith and Mr. John Oden of Talladega county, I am indebted for many and great favors; and a general acknowledgment is also made to others for courtesies extended to members of the geological party.

To the kindness of Mr. J. Blodget Britton of Philadelphia, and to Prof. Wm. C. Stubbs of the A. & M. College, Auburn, the Survey owes a number of analyses made by them for the Survey free of charge.

Others are mentioned below in the Chemical Report, who have generously allowed analyses made for their private use to be published.

Courtesies extended by the officers of the South and North Alabama, and the Selma, Rome and Dalton Rail Roads, are also gratefully acknowledged.

I am under special obligations to Mr. HIRAM HAINES for the careful manner in which he has revised the proof of this report.

I take pleasure in laying before my agricultural readers a short article on the Cotton Worm of the Southern States, from the pen of Mr. Aug. R. Grote, Director of the Museum of Natural Sciences, in Buffalo, N. Y. Mr. Grote has long been a resident of Alabama, and has had greater facilities for studying the habits of the cotton worm than any other entomologist in the country.

A more elaborate paper on this subject, illustrated by a lithographic plate, has been promised by Mr. Grote, and it will probably be given in my next Report.

EUGENE A. SMITH.

University of Alabama, Dec. 31, 1875.

GENERAL OUTLINE OF THE GEOLOGICAL FORMATIONS.

The examinations during the past season have been extended over parts of Bibb, Shelby, Talladega and Calhoun counties, where I have identified and given some details concerning the geological formations named below. For the sake of greater clearness, the sequence of these formations, beginning with the lowest, their general characteristics and their equivalents in Tennessee, are given in a condensed form.

In the preparation of these tables the general arrangement of Prof. Dana has been followed; but I am indebted to Prof. Safford, (Geology of Tennessee,) for many of the details.

A. Silurian Age. A.[1] Lower Silurian.

I. Primordial or Cambrian Period.

1. Arcadian Epoch.

   Characters. Semi-metamorphic slates and conglomerates; mountain making.

   Examples. Slates and conglomerates in the Eastern parts of Calhoun and Talladega counties, and exposed along Talladega creek, &c.

   Equivalents in Tennessee. Ocoee conglomerate and slates.

2. Potsdam Epoch.

   Characters. Sandstones and sandy shales; mountain making.

   Examples.—Ladiga mountain, Cold Water mountain, Parnassus, Alpine mountain, part of Kahatchee hills, &c.

   Equivalents in Tennessee.—Chilhowee sandstone.

II. Canadian Period.

1. Calciferous Epoch.

Characters. Sandstones and shales, calcareous and of various colors; ridge making.

Examples. Sandstones of Montevallo, Helena, Jackson shoals, and ridge West of Jacksonville.

Equivalents in Tennessee. Knox sandstone.

2. Quebec Epoch.

Characters. Shales, chiefly with some limestone in lower part; shales, variegated—dolomite, with chert in the upper part. The shales are valley making; the dolomite makes ridges and valleys.

Examples. Variegated shales and dolomite of Montevallo, Helena, Talladega, etc.; the dolomite underlies the greater part of Talladega and Calhoun counties.

Equivalents in Tennessee. Knox shales and Knox dolomite.

3. Chazy Epoch.

Characters.—Blue argillaceous limestone, often quite pure, generally highly fossiliferous; valley making.

Examples. Limestone at Pratt's Ferry, Siluria, Calera, &c.

Equivalent in Tennessee. Maclurea limestone.

III. Trenton Period.

1. Trenton Epoch.

Characters. Fossiliferous limestones, black, blue, and light colored; valley making.

Examples. Buff colored fossiliferous limestones near Pratt's Ferry in Bibb county, part of the dark blue limestones of Shelby, &c.

Equivalents in Tennessee. Trenton.

2. Utica Epoch. Not recognized in Alabama.

3. Cincinnati Epoch.

Characters. Shales weathering buff colored; ferruginous sandy limestone.

Examples. Shales, &c., a few miles West of Jacksonville, Calhoun county.

Equivalents in Tennessee. Nashville group.

A.[2] Upper Silurian.

I. Niagara Period.

Of this period the rocks of the Clinton Epoch only have been made out, in the region under consideration; equivalent to the *Dyestone Group* of Tennessee, and of this group only the beds of fossiliferous iron ore in Bibb county, have been identified as belonging here.

Of strata of the remaining periods of the Upper Silurian, viz:

Salina, Lower Helderberg and Oriskany, I know of no occurrence in the region examined.

B. Devonian Age.

The only member of this age occurring in Alabama so far as I know, is the stratum equivalent to the Black Shale of the Tennessee Report, and which is there placed as the representative of the Hamilton Period of the New York Reports.

C. Carboniferous Age.

I. Subcarboniferous Period.

1. Siliceous Group.

Characters. The characteristic rock, in this part of the State, is chert with impressions of shells, and especially of crinoidal stems; ridge making.

Examples. Cherty ridges between Montevallo and Calera, and at Calera, Shelby county; cherty ridges North from Calera, &c.

Equivalents in Tennessee. Silicious.

2. Mountain Limestone Group.

Characters. Limestones and shales.

Examples. The rocks of this group are best presented in North Alabama, but the shaly limestone, with fossils, six miles West of Columbiana, and also Southeast of Shelby Iron Works, probably belong here.

Equivalent in Tennessee. Mountain limestone.

II. Coal Measures,[2] or Carboniferous[1] Period.

Characters. Sandstones, shales and conglomerates, with *stone coal* interstratified.

Examples. The Coosa, Cahaba, and Warrior coal measures.

Equivalents in Tennessee and elsewhere. Coal measures.

D. Modified Drift.

GENERAL DESCRIPTION OF THE GEOLOGICAL FORMATIONS OCCURRING IN THE REGION EXAMINED.

In the preceding section, the names of the formations and their sequence have been given in tabulated form. It remains now to give a general description of these; after which, in a succeeding part of this report, the details of their occurrences in the different counties will be found under their respective headings.

SECTION I. LOWER SILURIAN.

I. PRIMORDIAL OR CAMBRIAN PERIOD.

The subdivisions of this period are, as above given—

1. ACADIAN EPOCH.
2. POTSDAM EPOCH.

As the strata of Acadian age have been examined particularly, only along Talladega creek, in order to save repetition, the reader is referred to the subdivision treating of these rocks under Talladega County. There is little doubt that the semi-metamorphic slates and conglomerate there described are the equivalents of Prof. Safford's Ocoee slates and conglomerates. Cabinet specimens from Talladega creek and from the typical Ocoee section in Tennessee, appear to be identical.

2. POTSDAM.

Next in ascending order, to the slates and conglomerates of the preceding group, comes a series of sandstones which form the most conspicuous mountains outside the Metamorphic and Acadian areas. The direct super-position of this sandstone upon the slates of the Acadian age, I have not seen in Ala-

bama, unless on the eastern edge of that belt, the prominent sandstone or quartzite ridge be, as seems quite probable, metamorphosed Potsdam sandstone. In the disturbed region of the Kahatchee hills, also, half metamorphosed slates are seen, some of which may belong to the Acadian epoch, whilst others are evidently altered Knox shales.

Lithological Characters, Distribution, &c—Fine grained conglomerates, heavy-bedded sandstones, and sandy shales, make up the great mass of the rocks of this formation. I have noticed also, occasionally, masses of a brownish porous chert, which, from its association with the sandstones, seems to be of the same age.

In general, the rocks of this formation are heavy bedded, almost massive, and the higher crests of the Potsdam mountains are usually covered with huge blocks of sandstone and fine grained conglomerate. In the lower parts of these ranges, sandy shales are the prevailing rocks. Some of the fine grained shales of semi-metamorphic aspect, found upon the Potsdam ridges of the Kahatchee hills, may be of this age.

The most characteristic markings of the rocks of this formation, are the sandy rods, caused by the filling in with sand of the burrows of a marine worm, *Scolithus linearis.* Upon the bedding planes of the sandstone, small rounded depressions, or dots, mark the cross sections of these Scolithus burrows. As yet I have found no other marks of organic origin in strata of this horizon.

From the nature of the rocks, it will be inferred that this is a mountain making formation, and the mountains of this age are, so far as our examinations have gone, the following: 1. Ladiga mountain, beginning north of Jacksonville, and running south and south-west to Oxford, where it ends. 2. Cold Water mountain, beginning at Oxford, near the termination of Ladiga mountain, and extending westward nearly to Choccolocco creek. 3. The Talladega range, beginning just south of Choccolocco creek, and extending south-westward to Alpine, where it terminates in three very prominent peaks, from which a short spur turns off towards the south. 4. The Kahatchee hills, beginning near Childersburg, and

forming, (1) a ridge following nearly the course of the Coosa river, and ending with the mountains about the Sulphur Springs; and, (2) a series of east and west ranges extending from the edge of the Acadian hills, in the lower part of T. 20, R. 4, E., and the middle of T. 21, R. 4, E., westward for eight or nine miles, and then widening out into the Kahatchee hills proper, south of Childersburg.

These mountains all rise abruptly from the surrounding plains, to heights varying from 375 to 1,225 feet above the plains. Characteristic, also, is the abrupt way in which a mountain range ends, the sandstones forming it disappearing entirely, thus forming isolated chains.

The strata in the mountain ranges enumerated, all dip at tolerably high angles SE. or S., with the exception of one small part of the east and west range of the Kahatchee hills, Pope mountain, where the dip is north.

Upon the side opposite the direction of the dip, these ranges are bounded by *faults*, the Potsdam having in most cases been brought up to the level of the Knox dolomite, though in several instances, it seems, to the level of higher groups. In the Kahatchee hills, and near the Sulphur Springs, there is reason to believe that the displacement has brought the Potsdam sandstone to the level of the *Black Shale*. The broken edges of the Potsdam rocks seem to be thrust up through the overlying formations.

All these mountains are, as Prof. Safford has noticed in Tennessee, great *outliers*, being found at distances varying from three or four, to ten and twelve miles, from the mountains of Acadian slates, with a valley or lower tract of Knox dolomite intervening. In Calhoun county, several subordinate ridges of very moderate height have been noticed between the main outlying mountain of Potsdam sandstone and the Acadian hills.

The nature of the rocks of this group, conglomerates, sandstones, and sandy shales; the fossil markings, principally the burrows of marine worms, &c., all point to a sea-shore origin.

Useful Materials.—Many of the rocks described above would make good building stone, especially the more sandy and less

compact portions: some of the shales might be used as flagstones. Pyrites seems to be widely disseminated in these rocks, giving rise by its decomposition to numerous chalybeate springs.

Agricultural Features.—As a matter of course, good farming lands could hardly be looked for upon the barren sandstone mountains of this age.

Many additional details may be found under the several counties, especially Talladega.

II. CANADIAN PERIOD.

In the condensed view of the geological formations, given above, I have adopted Prof. Dana's classification of this period into the Calciferous, Quebec, and Chazy epochs; by which the equivalent of the Alabama rocks are sufficiently well shown.

In the sequel I shall follow the subdivisions of Prof. Safford, and throw together the Calciferous and Quebec groups, under the general name of *Knox Group,* so called from Knoxville, Tenn., where the formation is best seen.

The Knox group, according to Prof. Safford, is of threefold nature; below, thick and thin bedded sandstones and hard shales, passing upward into shales of various colors, and these into limestone or dolomite.

The group is therefore divided into

1. Knox Sandstone.
2. Knox Shale.
3. Knox Dolomite.

These three subdivisions form in Alabama, as well as in Tennessee, *lithologically* a natural group, for the sandstones and shales are separated by no well marked line of distinction: the colors of the rocks even, though universally bright and pleasing to the eye, are much the same in both divisions. So, also, the upper part of the shales holds interpolated beds of limestone, by which its transition into the overlying dolomite is made by easy gradations, and the line between them correspondingly difficult to draw.

Another circumstance which has its weight may be here

mentioned: from personal observation, I know that the sandstones, shales, and dolomite, of the Tennessee Knox group, have their exact equivalents in Alabama, and considering the geographical relations of the two States, I have thought it best to adopt the same names.

Occasionally, below, the term Calciferous Sandstone is used, as equivalent to Knox Sandstone, and Quebec Shales and Quebec Dolomite, as equivalent to Knox Shales and Knox Dolomite; but with the explanation given above, there will scarcely be any danger of misunderstanding.

1. Knox Sandstone.

The rocks of this group succeed next, in ascending order, the Potsdam Sandstone, and they are often, no doubt, found resting directly upon that rock. I have not, however, often seen them in this position; but much oftener just on the south-east side of a fault by which they have been raised to the level of a much higher formation. This sandstone is more generally associated with the shales of the next higher group, and these with the dolomite, so that three groups are usually closely associated *geographically*, as well as *lithologically*.

Kinds of Rock, Distribution, &c.—A calcareous sandstone; sometimes thick, sometimes thin-bedded, is the characteristic Knox Sandstone.

It is associated with hard calcareous shales, much like the shales of the next higher division. The bedding planes of the sandstone commonly show ripple marks, and irregular raised markings which are commonly supposed to be fucoidal impressions. The bedding planes are also frequently smooth, and shining as if polished. Green grains of a glauconitic mineral are usually to be seen upon a fresh fracture of the sandstone; upon weathered surfaces, the brown color of hydrated ferric oxide is often the result of the decomposition of this mineral. The colors of the Knox Sandstone are pleasing to the eye, and are gray, greenish brown, buff, chestnut colored, &c. Beds of dolomite, impure and cherty, are found in the upper part of this formation; two such calcareous beds

were noticed in the exposure of Knox Sandstone at the Jackson shoals, and also at Helena.

From the nature of the rock, prevalently a hard sandstone, alternating with shales, this formation is a ridge making one, and the ridges are usually rather sharp crested. Where the formation is cut by a water-course, the wearing out of the intervening softer shales, leaves the sandstone layers in a series of ledges exposed above the water level; good instances of this may be seen at the Jackson shoals, at Helena, and on Six Mile creek in Bibb county. Such natural dams afford fine mill sites, as the water power can be utilized with very little expense.

The Knox sandstone is found next to the Coal Measures of the Cahaba fields, from which it is separated by a fault, at Montevallo, at Helena, and between those two places. Probably, also, it lies south-east of those coal fields further north, though I have not yet had the opportunity of observing personally any further north than Helena.

At the latter place the junction of the two formations may be seen a short distance above the rail road bridge across Buck creek.

In Talladega county, west of the Potsdam sandstone range, a ridge of Knox Sandstone is brought up by a fault against Knox Dolomite; and three miles west of Jacksonville in Calhoun county, a similar ridge has on its western side strata of the Cincinnati group. In Bibb county the sandstone is brought up to the level of the Chazy, or perhaps Lower Trenton. It will thus be seen that where Knox sandstone is best exposed it is on the south-east side of the line of a fault.

It would naturally be looked for, overlying directly the Potsdam sandstone of the mountains enumerated in a previous section; but it is not always easy to distinguish it: since, however, these ridges of Potsdam sandstone have a well defined belt of Knox Shales on their eastern and south-eastern flanks, the Knox Sandstone, probably in most cases, intervenes between the two.

Useful Materials.—The sandstones and shales of this division are commonly rich in iron, and under favorable circum-

stances beds of limonite may be formed; but the ore banks are almost entirely confined to the upper division—the Dolomite.

The sandstones are occasionally used for building, in rough work, such as dams, pillars, &c., and the calcareous beds furnish sometimes the material for lime burning; for which purpose, however, they are ill adapted.

2. Knox Shales.

The characteristic rocks of this subdivision of the Knox Group are calcareous shales of bright and agreeable colors, usually gray, buff, greenish, brown, chestnut-colored and red. The shales are tolerably soft, and in some portions in weathering, break up into small angular pieces resembling shoe pegs. Strata of dark blue limestone, sometimes banded with argillaceous layers, are found, especially in the upper part of this division. The weathering of such limestones brings into relief the bands or stripes of argillaceous matter, and the limestone appears very distinctly banded. Where these impurities are not so regularly disposed in layers, but in patches, the prominence given to them by the weathering away of the limestone gives them a striking resemblance to half exposed fossils.

In some places layers of dark colored oolitic limestone have been observed, one of the best localities of this peculiar rock being at the foot of the mountain at Alpine Station in Talladega county.

In the upper part of the division blue limestone layers become more frequent, and the transition into the overlying Dolomite is so gradual that a line between them lithologically is hard to draw.

From the nature of the shales, they are constantly found in valleys, an exception being in some of the very impure layers of argillaceous limestones, which are sometimes found making small ridges. An instance of this kind may be seen near Montevallo, where the clayey limestone forms bluffs overhanging the little stream known as Davis' creek.

The Knox Shales are found with Knox Sandstone, in Bibb county, in one or two belts, as described below in the proper

place; also with the sandstones on the south-east of the fault separating the sandstones from the Coal Measures at Montevallo, Helena, &c.; also overlying the sandstone where the latter makes the ridges mentioned above in Talladega and Calhoun counties; and lastly upon the south-eastern flanks of the ranges of Potsdam Sandstone already enumerated. Between the Ladiga mountain and the hills of Acadian slate in Calhoun county, there are numerous small ridges of Potsdam sandstone, on the flanks of which the Knox Shales seem never to be wanting.

I have not yet observed any fossiliferous strata in this division.

The soils produced by the Knox Shales are usually productive, strengthened by the calcareous matter contained, but rather liable to suffer from drouth.

With the exception of occasional small beds of limonite, I know of no useful mineral obtained from this division. Some of the limestone layers, especially in the upper part, are pure enough for lime burning.

3. Knox Dolomite.

This succeeds the shales in ascending order, and as has already been stated the line between the two is hard to draw, since the lower parts of the Dolomite contain beds of blue limestone similar to those in the upper part of the Shale. One of the best localities for studying the rocks of this entire group, from the sandstone up, is the vicinity of Montevallo, where they are well exposed. In the western part of the town the beds of blue limestone, which are found near the base of the Dolomite, are well seen.

Speaking of this division in Tennessee, Prof. Safford says, "it is the most massive formation of calcareous strata in the State." The same remark may be made of its occurrence in Alabama. A large part of Bibb and Shelby, and by far the greater part of the areas of Talladega and Calhoun, are underlaid by the rocks of this formation.

Lithological Character, &c.—The blue limestone layers in the lower part of the Dolomite have been mentioned: these are interstratified with shales; following these, come thick

beds of gray dolomite, crystalline, sometimes sandy, and usually much contaminated with chert. The presence of chert throughout the dolomite gives rise to the numerous rounded ridges which are so characteristic of this division. The dolomite is often so charged with sandy matter as to resemble to some extent a sandstone, and as it resists denudation, it is frequently found making small hills and ridges: the exposed surfaces of such dolomites are generally crossed with furrows, giving them a hacked appearance.

In some of its exposures, the upper part of the Dolomite has layers of impure blue limestone which are said to be good lithographic stones; but a more characteristic feature of the upper part is the great amount of chert which it contains. In some parts of Talladega and Calhoun counties, where this chert abounds, the dolomite is inconspicuous, its presence being indicated chiefly by the "lime sinks" or depressions caused by subterranean erosion and subsequent caving in of overlying strata, the whole country being made up of a series of rounded chert ridges, covered with a growth of long-leaf pine.

Prof. Safford gives as a characteristic of the chert from this horizon, the rhombohedral cavities with which it is frequently pitted: the cavities being the moulds from which crystals of dolomite have been weathered or dissolved.

An equally good characteristic of it is given by Prof. Frank H. Bradley, in its concretionary structure. Such are also its characteristics to some extent in Alabama; but much of the chert which I have examined shows neither characteristic.

It is found sometimes in large rough cavernous masses, imbedded in red clay, giving evidence of its origin from cherty limestone or dolomite. Again, the gray angular flint gravel which covers most of the ridges of the division are of chert; frequently, also, it appears less like chert and more like a sandstone.

The distribution of the rocks of this division in the different counties may best be seen by referring to those headings.

Topography, &c.—From the presence of so much chert throughout the Dolomite, this is a ridge-making formation, and especially in those parts where the chert abounds. Be-

tween the cherty ridges are, on the other hand, often smooth and fertile valleys. The road from Talladega to Syllacauga, over Knox Dolomite, is one of the best in the State, though numerous cherty ridges are crossed.

It is worth noticing that where there is great abundance of limonite, and the clay of the soil is impregnated with iron, the soil is usually quite productive, and the country gently rolling rather than broken. Where limonite is found in the broken chert hills, it is very often largely contaminated with the chert.

As to the thickness of this formation in Alabama, I have no reliable data for a correct estimate ; it must be, however, very great.

Useful Materials.—The dolomite holds layers of black limestone with reticulating veins of white calcite, which are worked into handsome slabs. The black marble in Talladega county is of this nature. Where exposed to metamorphic action, the dolomite sometimes affords good statuary marble. I have ventured to assign the crystalline marbles of Talladega county to this horizon; fuller details concerning it can be found in Tuomey's reports, and below in this report.

Calcite, the crystallized carbonate of lime, is quite common in veins and crystalline masses. The best occurrence of calcite in very large masses is near Syllacauga, where it has been used for lime burning. Specimens from here showing cleavage faces several inches in diameter are easily had.

Dolomite, carbonate of lime and magnesia, is common in crystals lining cavities in the rocks of this formation, and the same may be said of *Quartz*, which is of frequent occurrence.

Barite or *Heavy Spar*, is found in veins at several places in Bibb county, e. g. near Maguire's Shoals on Little Cahaba, near Six Mile creek, &c. In Shelby, east of the railroad (S. & N.) opposite Whiting, or Longview; also in Talladega and Calhoun at several points.

Black Oxide of Manganese, commonly accompanies the ores of iron, as near Woodstock furnace, where tolerably pure specimens are to be found. Much of the limonite in some localities has a considerable percentage of manganese. Near

Kelly's creek in Shelby county, very pure black manganese was found in a mass of several inches in thickness, in digging a well.

Galenite, (Sulphide of Lead.)—A limestone or dolomite of Calhoun county, west of Jacksonville, impregnated with galenite has for many years been known, but as yet no vein of the ore has been discovered, and the amount of lead in the limestone is not sufficiently large to pay for working.

Limonite or Brown Hematite, is the characteristic mineral of the Knox Dolomite. The other two divisions of the Knox group, show occasionally such accumulations of limonite as to justify the name of ore banks; but it is to this upper division that the productive ore banks are confined, and it seems to be the fact that the largest accumulations of limonite occur in the belt of the dolomite which lies nearest the mountains of semi-metamorphic slates of the Acadian Epoch, though ore banks sufficiently large to justify the erection of blast furnaces, are found at a distance from the mountains.

Of the origin of the limonite, I think there can be very little doubt that it has been set free by the decomposition and wearing away of ferruginous limestones and dolomites, and deposited in beds at or near the places once occupied by the limestones. There seems to be little evidence to show that the ore has been far removed from its original position, though some of it has evidently been so moved. The beds of ore, following as they do the outcroppings of certain strata, have something more than an accidental connection with such strata. This opinion has long been held by some geologists, though others hold to opposite views.

I have occasionally seen limonite which has undoubtedly been derived from the oxydation of pyrite; and one instance may be cited in an occurrence near Oxford, Calhoun county, where masses of limonite, on being broken open, show a nucleus of unchanged pyrite; and again, the pseudomorphs of limonite after pyrite, are not very rare.

As to the quality of the ore, analyses show that a great part of it contains too much phosphorus for use in making Bessemer steel, whilst for ordinary foundry iron, for commer-

cial bar and rails, it is most admirably adapted. A few very extensive ore banks, however, show that small percentage of phosphorus in the ores, which fits them for making Bessemer metal.

It must be remembered that ores have as yet been analyzed from a few only of the many localities where they occur, and that analyses made hereafter, may show many other banks, where the ore is comparatively free from phosphorus.

In this connection, I may remark that the manufacture of steel is likely soon to be placed upon a new footing, by the discovery of a process by which steel may be made from the common phosphoric irons, instead of the rare non-phosphoric irons which have hitherto been alone considered the only material from which steel could be made.

A patent for this process has lately been issued.

Before leaving this division, mention may be made of the many bold limestone springs which are found everywhere in the region of Knox Dolomite.

A few of the most notable of these springs will be noticed below in the details of the counties.

The so-called "lime sinks," are likewise frequent in the same area. In a few instances which have come under observation, considerable streams have in some parts of their courses underground channels; as Six Mile creek in Bibb county above Centreville.

Chazy Epoch.

The upper part of Knox Dolomite passes into the chazy limestone, which is, in general, an argillaceous limestone, of blue color. It sometimes, in weathering, breaks up into irregular knots or lumps, sometimes with more or less regular blocks. This last character, however, is usually noticed where the limestone is thin bedded and flaggy. Other portions of the chazy limestone are quite pure, and compact, and large, smoothly rounded masses of it are not uncommon, with the marking of its characteristic fossil, *maclurea magna*, upon weathered surfaces. Where the rock is not very thick bedded and somewhat homogenous, the upturned edges of the beds

may be seen outcropping in parallel lines over considerable areas. The regions about Siluria station and northward, afford good examples. Red cedar is the usual growth upon such tracts.

The chazy limestone has been observed in Bibb and Shelby counties, next adjacent to the Knox Dolomite; in Shelby county it is seen in five or six alternations with sub-carboniferous chert, between Montevallo and Calera. The greater part of the limestone at the last named place, as well as northward towards Longview, Siluria, &c., is chazy; but it is probable that the upper portions of the limestone beds found at the places mentioned, may be of Lower Trenton age, (*i. e.* Black river, or Bird's Eye Limestone); but as yet the fossils have not been collected, which can decide this point.

Upon many of the rounded weathered masses of limestone of this period, little ridges are common, radiating from a raised central point, "as if the fingers had been drawn over it when soft."

Outcrops of chazy limestone in Talladega, I have not yet seen; but in Calhoun, one belt has been noticed with the Cincinnati beds west of Jacksonville.

Useful Materials, &c.—Most of the limestone for lime burning in Bibb and Shelby counties, is obtained from this horizon, or from the beds of the Lower Trenton just above it, it being as yet not possible to determine whether beds of the latter group do not make part of the limestone strata in those localities where the lime burning is carried on.

The excellence of the Shelby lime has long been known, and the purity of the rock from which it is made, is sufficiently evident from analyses given below.

TRENTON EPOCH.

Since beds of this age have been definitely recognized as yet, only in one locality in Bibb county, it is not deemed necessary to repeat here what is said below, and the reader is therefore referred to the section treating of the occurrence of Trenton limestone in Bibb county.

Cincinnati Epoch.

The buff colored shales with interpolated beds of marble, and Iron-limestone, a few miles west of Jacksonville, are the only Cincinnati beds observed in the counties examined during the summer, and the remarks upon this occurrence will be found under Calhoun county, to which the reader is referred.

Section II.

UPPER SILURIAN, CARBONIFEROUS, MODIFIED DRIFT.

UPPER SILURIAN—NIAGARA PERIOD.

Beds of this period have been observed in Bibb county, a few miles north of Centreville, from which point they extend, with occasional interruptions, north-east into Georgia and beyond. The fossiliferous or lenticular iron ore bed of the *Clinton Epoch*, of the Niagara Period, which is the particular stratum under consideration, is that which furnishes the ore for several furnaces north-east of Bibb county. A fuller discussion of this and associated beds must be deferred to a future report, which is to treat more especially of the geology of the Silurian Valley, which, under the names of Roup's Valley, Murphree's Valley, and Willis' Valley, traverses the State from Bibb county north-eastward into Georgia.

Carboniferous Age.

This age we have subdivided, as above shown, into the
Sub-Carboniferous Period and the
Carboniferous Period, or Coal Measures.

The sub-carboniferous rocks in the region examined, belong probably to two groups which are named from the Tennessee Report, the
1. *Siliceous Group*, and
2. *Mountain Limestone.*

In the States further north, this Lower or Sub-Carboniferous Period is susceptible of several well defined divisions. In Tennessee, these divisions are not so well marked, and it is probable that in our own State, the same will be found to hold

good. In Shelby county two very distinct occurrences of sub-carboniferous rocks have been observed; the one, forming several well defined ridges alternating with chazy limestone, between Montevallo and Calera; at the last named place, and also in ridges running north from Calera, on the eastern side of the S. & N. R. R.

The principal rock of these ridges is a chert, filled with the impressions of shells, crinoidal stems, &c., and cellular or porous in consequence of the removal of the calcareous matter of the shells.

Some of the specimens have been submitted to Prof. A. H. Worthen, of Illinois, and have been pronounced by him as of the Keokuss age of the Lower Carboniferous of the Illinois Reports, which is partly, at least, equivalent to Prof. Safford's Siliceous Group.

The other occurrence of sub-carboniferous rocks in Shelby, is between Siluria and Columbiana; but still better defined some miles south-east of the Shelby Iron Works, where several beds of an argillaceous blue limestone, weathering into shale and highly fossiliferous, are found. From fossils of this locality submitted to him, Prof. Worthen considers them as probably of the age of the Chester Limestone of Illinois Reports, which is, I presume, the equivalent in part of Safford's Mountain Limestone. The mountain limestone, however, has its best development in North Alabama, still it is interesting to know that beds of this and the preceding age of the sub-carboniferous, are found so far south in Shelby county, where their existence has heretofore, I believe, not been suspected.

Useful Materials.—Upon the flanks of most of the ridges of chert of this period, are found banks of limonite, sometimes of considerable extent. As a general thing, however, the limonite encloses chert, often pulverulent and resembling chalk, which interferes seriously with its fitness as an ore of iron. No analyses of this ore have been made as yet for the survey, and I do not know whether it contains other deleterious admixtures or not.

Some of the cellular masses of chert are quite hard and flinty, and would doubtless make excellent buhr stones.

Coal Measures.

As a preparatory step to the full and complete survey of our coal fields, it seemed to me very desirable that a short account of the development of the fields up to the present time; the methods of mining; modes of shipment; of the different mines worked; their product, capacity, &c., should go before. Accordingly, I requested Mr. T. H. Aldrich of the Montevallo coal mines, to collect for me notes upon the coal fields, with a view to the publication in this report of such a preliminary sketch as that outlined above.

To this request Mr. Aldrich has kindly responded, and he has thrown together his notes in the following form. I doubt not that the information conveyed in these notes, will be very acceptable to all of our readers:

I. HISTORICAL ACCOUNT OF COAL MINING OPERATIONS IN ALABAMA SINCE 1853.

Cahaba Fields.

The first systematic attempt at the mining and shipping of coal, was made in the Cahaba coal field near its southwestern extremity, above Pratt's Ferry and on the right bank of the Cahaba river. The company was formed by a number of the citizens of Montgomery in 1853; the coal was mined by drifts and loaded upon barges, with the expectation that the navigation of the river would be practicable. A few barges were loaded and started down the Cahaba; all of them, with the exception of one, were wrecked upon the rocks and shoals of the lower falls at Centreville. The barge that escaped was floated down the river to Cahaba, and thence up the Alabama river to Montgomery.

After this attempt the enterprise was abandoned, the difficulties in the way of navigation of the river being at the time deemed insurmountable.

The citizens of Bibb and Shelby counties, for many years previous to this attempt, had been in the habit of obtaining

coal for blacksmithing purposes from the Cahaba fields. In 1852, Mr. D. H. Carter, then residing near Montevallo, mined several car loads of coal from what is now known as the Lemley seam, hauled it to the terminus of the Alabama and Tennessee Rivers Rail Road, (now S., R. & D. R. R.) and shipped it to Montgomery, where it was sold for $6.00 per ton. The coal was used principally for blacksmithing purposes.

These attempts at mining of coal, and the prospect of the early completion of the Alabama & Tennessee Rivers Rail Road to Montevallo, directed attention to the eastern part of the fields. In 1855, a charter was obtained by a number of the citizens of the State, and a company organized under the title of "*The Alabama Coal Mining Company.*" In this connection, I take pleasure in calling attention to a report upon the coal lands of this company, made by Prof. Tuomey in October, 1855. (See Appendix "A.") It will be seen that this report was intended to be incorporated in Prof. Tuomey's Second Biennial Report to the Legislature, but on account of his death, and the scattering of his notes and papers, it was never published, and no apology is necessary for its reproduction here. It is interesting to notice the accuracy of Prof. Tuomey's observations, notwithstanding the difficulties in the way of geological explorations at that early day, as well as his philosophical speculations upon the probable future of the coal trade in Alabama. The very same hopes and expectations are indulged in to-day, perhaps with a better prospect of their early realization.

In conformity with Prof. Tuomey's recommendations, a slope was sunk and a fine engine erected upon what is now known as the "Shaft Vein," which is one of the highly inclined series. This opening was in the south-east quarter of the north-east quarter of S. 1, T. 24, R. 11, E., of the Lower Survey. The depth of the slope is 175 feet. At 150 feet depth headings were turned off, east and west along the vein, and mining operations regularly begun. The branch railroad, still used for the purpose of transporting coal, was energetically pushed through to completion by the Company, and shipments of coal were made to Selma, and thence to other

parts of the State. Operations by this Company were continued till the latter part of 1859, or the first of 1860; the largest amount shipped by them in this time being 33 tons per day during one month.

Owing to several fatal accidents, the difficulties of keeping a sufficient force employed at the mines were very great, and the creation of a market for their products being a slow process, and expensive, the project was abandoned.

As far back as 1836 coal was obtained from what is now known as the Fancher Pit. At this opening, as well as at the Wood's Pit, both openings being upon the Montevallo vein, the Alabama Company had obtained small amounts of coal.

The war beginning, renewed attention was directed to these fields, and in 1863 the *Montevallo Coal Mining Company* was organized, and a purchase made of the lands, plant, and rail road of the Company. Energetic work was now begun upon the Montevallo vein; new pits were opened, and coal extracted at the Fancher Pit, the Wood's Pit, and at many other openings along the outcrop of this vein. The largest shipment made was eighty tons per day, although the capacity of the mines was far greater than this.

At the close of the war a lease was made of these works by Mr. E. G. Walker, now of Montevallo, who carried them on till their purchase by the *Central Mining and Manufacturing Company*, the remaining lands of the Montevallo Coal Mining Company passing into the hands of other parties.

The Central Mining and Manufacturing Company continued operations above the water level, principally at what is now called the Irish Pit, until the latter part of 1867, when a slope was sunk at this point six hundred feet deep, a double cylinder engine of 40 horse power was placed in position, a narrow guage road built to the main branch, where a fine shoot was erected. The slope was sunk in the coal, which dips one foot in nine, north 2 deg. east; the system of mining being that known as *long wall advancing*. The engine was placed ninety feet vertically below the surface of the ground, the smoke being carried up by a shaft to the surface, and the water raised by a steam pump.

This mine was next worked by the purchasers under a mortgage, Messrs. Josiah Morris and others. The property then was redeemed, and leased in 1870 or 1871, to the *Cahaba Coal Company*, who worked it for about twelve months. It then passed into the hands of the late Albert Williams and others. These parties began operations under the firm name of Messrs. Holt, Varner & Co., in 1872, Mr. S. D. Holt being the active manager. This firm continued the work here until the final abandonment of the mine, in the spring of 1874, mining during the last twelve months between 12,000 and 13,000 tons of coal.

The late William P. Brown of Montevallo was the owner of a considerable tract of land adjoining the lands of the Old Alabama Mining Company, embracing part of the vertical veins as well as the Montevallo vein. Pits were sunk by him at several points along the outcrop of the Montevallo vein, and worked in a small way from 1856 to 1863, when a sale was made of this property to a Company organized as the *Mobile and Selma Coal Mining Company.*

This Company worked the Montevallo vein only, at a point near the Irish Pit, their headings even connecting with those of the old pit; and also at a point in S. 19, T. 22, R. 3, W., near the center of the section, now known as the Brown opening. This opening is in a ravine, at about the lowest point on the eastern edge of the field, and within 500 feet of the Silurian rocks. The vein at this point dips N. 4 deg. E., and at an inclination of about 1 in 10.

The Company built a branch road from the main branch to this opening, erected shoots, &c.

Operations were carried on here by the Company till the close of the war, only a small amount of coal being mined. In 1866 the mine was leased to Mr. William P. Brown, the former owner of the property, who worked it about two years; it was then leased to the Cahaba Coal Company, who also worked it about three years, driving the main gangway a distance of 1,000 feet. The mine was then leased by Mr. D. A. Smith, who sold out in February, 1873, to T. H. Aldrich. Mr. Smith mined about 4,500 tons of coal during the time of his lease.

The working was continued by Mr. T. H. Aldrich, upon the water level, and in the summer of 1875 the drift had been carried to the boundary of the property, a distance of 2,800 feet from the mouth. The amount of coal mined in 1873 was about 7,000 tons, and in 1874 about 12,000 tons. In May, 1875, a slope was started at a distance of 1,300 feet from the mouth of the mine, and continued down on the dip towards the basin, a depth of 300 feet, and a new "lift" was started. The output of the mine for 1875 is about 16,000 tons.

At the head of the slope a chamber was cut out of the "solid," a 40 horse power engine and boilers put in, connecting with the surface by a shaft through the overlying conglomerate 103 feet in thickness.

A fact worthy of notice is the manner of filling the boiler with water. A tank on the surface fed by an unfailing spring of pure water, is connected by a siphon made of 1½ inch gas pipe passing through the shaft, directly with the boiler below. The weight of the column of water is sufficient to fill the boiler against the usual steam pressure, and the warm air ascending in the shaft heats the water so that a heater is unnecessary.

To complete the historical account of the operations in this region, it may be stated that a small amount of coal has been mined by T. S. Alviss & Co., from the Lemley vein, and used in the puddling furnace at Brierfield, and coke made from the same coal mixed with charcoal was used, with poor results, in the blast furnace.

The necessities of the Confederate Government in 1863 gave an impetus to the exploration of the Cahaba coal fields, as a large foundry for making cannon and heavy ordnance was located in Selma, and a good quality of coke was needed for melting the pig iron. Many openings were made along the veins in the immediate vicinity of the Cahaba river. The principal openings, beginning at the lowest, or most southerly, are here given. Thompson's Lower Mine, on Pine Island Branch, in S. 10, T. 24, R. 10, E., on the Gholson seam: coke

was made here in the open air and hauled over the hills to the rail road for shipment to Selma. At the close of the war a large amount of coal was left at the mouth of the pit, and the inhabitants in the vicinity have supplied themselves with fuel from this pile up to the present day. The excellent quality of this coal is shown by the fact that it burned freely in grates after years of exposure to the atmosphere.

The next opening is in the north-west part of S. 1, T. 24, R. 10, E., upon the Thompson seam, known as the Thompson Upper Mine.

Next above is the Herndon Mine, about 1½ miles north-east of the Thompson Mine, and upon the same seam. Openings at this point were also made upon a seam underlying the Thompson seam.

A large quantity of coke was made in the adjoining parts of sections 12 and 13, T. 22, R. 5, W., at the Coke Seam opening and the Gholson opening, upon the coal seams bearing those names, near Daly creek.

Mr. George H. Gardner opened what is called the Big Seam, upon fractional S. 28, on Little Ugly creek, on the west side of the river; but the coal proved too soft to be of much value.

Further north, several (nine or ten) openings were made upon the Gholson Seam and one underlying it.

The coal from these places was found to make an excellent quality of coke. It was used with great success in casting cannon at Selma. Most of these openings are in S. 29, T. 21, R. 4, W.

Next towards the north, in the vicinity of Helena, we arrive at another point where active operations were conducted during the war. The South & North Alabama Rail Road was built with a temporary track from Calera to this place, and a branch road one and three quarters of a mile in length, was run out into the central part of the field to afford the facilities for handling and transporting the coal iron.

A very large force was employed in building the tram roads, shoots, &c., and an enormous number of openings was made simultaneously upon four or five different seams. This

was done principally in the years 1862 and 1863, the *Red Mountain Iron and Coal Company* being the chief operators. Two slopes were sunk upon the Helena seam; a long tram road was built, reaching down nearly to Beaver Dam creek, the greater part of the coal being taken from the Helena and Beaver Dam seams.

During these two years and up to the close of the war, it is estimated that over 30,000 tons of coal were mined in this vicinity. A large amount remained at the mines, and was shipped after active mining operations were discontinued, and five thousand tons in one pile were burned at one time at the company's shoots.

A slope was also sunk, about one hundred feet deep, upon the Little Pittsburgh seam, by Messrs. Raney and Holmes.

Messrs. Moyle and others, also sunk a slope upon what is known as the Moyle seam. A fine engine and proper machinery were erected, and active operations were kept up until 1865, when the plant was destroyed by Wilson's raiders, and nothing has since been done at this mine, which is known as the Southern Mine.

Messrs. Woodson & Gould opened in 1863 the Cahaba seam by a slope near the river in section 9, upon the north dip of this seam. A more detailed description of this opening will be given below under the heading of the Cahaba Coal Company.

Cahaba Coal Company.

In 1866, Messrs. Woodson and Gould sold out their mine to a company organized under the name of the Cahaba Coal Company, composed chiefly of northern and western men. At the time of their purchase the slope had been sunk three hundred feet, a small engine had been erected, and the water was hoisted by means of a water car. This company continued the slope and mined extensively until the following year, 1867, when the mine was flooded by the great freshet of that year.

Notwithstanding this disaster, the company pumped out the water and began anew. In 1868 the temporary track of

the S. & N. R. R. being in bad condition, this company leased it and put it in a complete state of repair. It will be remembered that they were at the same time the lessees of the Brown Mine, belonging to the Mobile & Selma Coal Mining Company, and that they also controlled, through Col. R. M. Moore, their Superintendent, the Irish Pit; thus having sole control of the entire trade. In the latter part of 1869 or in 1870, the company discontinued the business.

It is estimated that up to the year 1870, the Cahaba Mine had produced over 40,000 tons of coal.

In the spring of 1872, the mine was again flooded, and so remained until the summer of 1874; it was then leased by Mr. S. D. Holt, who, in the short space of three months, pumped out the water and began work. He has sunk the slope one hundred and sixty feet further towards the centre of the basin, and started two new lifts. The present production of the mine is about sixty tons per day.

The mouth of the slope being lower than the air course openings, the water first found entrance to the mine there, carrying down in the rush the blacksmith shop and an immense amount of debris from the immediate vicinity. The rush of water was so rapid that air in the lower courses was strongly compressed, and burst out from the other openings with a loud explosion. It was supposed by many, incorrectly as events have shown, that this explosion had ruined the mine by letting in the waters of the river, as the headings on the west side of the slope extend under the bed of the river.

Glasgow Coal Company.

In 1866 or 1867, William Gould and others, having sold out their mine to the Cahaba Coal Company, opened a new one upon what is now known as the Gould seam, at a point about 1¾ miles north-west of their former one. This seam was found to yield an excellent coking coal. The mine was first worked by drifts above the water level; but afterwards a slope was sunk, and the hoisting was done by means of a whim. The seam is quite irregular, averaging about four feet in thickness; the dip being about 20 degrees towards the

south-east. The coal is soft and easily mined. After some years time, work was discontinued here, partly on account of the small demand for coal and coke, partly on account of the difficulties in getting to the rail road; a long and expensive tramway having to be kept in repair. The mine has been for some time, and is now, worked by Mr. D. C. Bozeman. The coal has an excellent reputation for blacksmithing purposes.

Alabama Mining and Manufacturing Company.

This company was organized in 1 74, and made a lease of the coal lands of the Red Mountain Iron and Coal Company. The Wadsworth or Eureka Mine, on this property was opened in 1867 by F. L. Wadsworth and others; the slope was sunk one hundred and eighty feet and gangways driven. These parties discontinued operations in 1868, for want of transportation. From 1868 to 1872 the Red Mountain Iron and Coal Company worked the mine, producing only a small amount of coal each year.

In 1872 the mine was leased to Messrs. Leavett and others, who erected an engine, pump, and other necessary appliances. These parties worked one season, and were succeeded in 1874, as above stated, by the Alabama Mining and Manufacturing Company.

This company has sunk the slope one hundred and ten feet further, and turned off a second lift, and are now mining about thirty tons per day, the capacity of the mine being about eighty tons per day. Preparations are being made to mine extensively with convict labor. The seam is a little irregular and the coal somewhat soft; but from analyses and tests made at the Eureka Iron Works, it is ascertained to be a very fine coking coal, and it is the intention, when these furnaces go in blast, to use the coke made from this coal as fuel. The machinery, shoots, and buildings at these works are arranged for a very extensive business, and are well worthy of examination. The plant here is in many respects, superior to any in the State.

Davis and Carr's Mine.

This mine was opened in 1871 by drifts. In 1873 the proprietors opened a slope a few yards distant from the rail road. The angle of dip here is about 25 degrees, and the slope is sunk 290 feet. This mine is on the south dip of the Cahaba seam, the Cahaba mine being, as was stated above, on the north dip, and about one-fourth of a mile distant southward. The coal is similar to that of the Cahaba mine, being regarded as a very fine coal for household purposes, and meeting with a ready sale. The thickness of the seam averages about three feet, and it has an excellent roof. The water and coal are hoisted by an engine of about twenty horse power, and the capacity of the mine about 8,000 tons per year.

Messrs. Byram and Bowers.

This firm has been working at two points upon the Helena seam since 1872, about one mile south-west of Helena; the old drift having been opened during the war, by the Red Mountain Iron and Coal Company. They also work a slope which connects with this drift, the coal being hoisted by means of a whim. Very little is done at this mine, except during the winter season; the coal is hauled by wagons to Helena.

The seam averages at this point three feet nine inches in thickness, and is a superior household and furnace coal, very free from sulphur. The capacity of these openings is about twenty tons per day.

During the year (1875), Mr. D. C. Bozeman has commenced sinking a slope on the Little Pittsburgh seam, near an old drift which was also opened during the war by the Red Mountain Iron and Coal Company. The seam at this point is about two and a half feet thick, very hard, and an excellent lump coal.

An opening was made in 1874 upon the Shortridge seam, in section 20, a drift being driven in at the water level, about 200 yards. The coal was used to supply the Helena Rolling Mill, (Central Iron Works,) where it gave great satisfaction.

The vein is about three and a half feet thick at this point; the coal is hard, and makes an excellent coke.

COOSA FIELDS.

These fields being at a distance from any rail road, and the Coosa river not being navigable, have been very little explored. Some coal was mined years ago from the beds of the streams crossing this field, and carried during high water, by means of boats, to Montgomery. Some mention is made of this field in Prof. Tuomey's Reports, to which the reader is referred.

In 1863–64 Capt. Schultz of the Confederate army made a large quantity of coke from the seams in this field, getting it to market by floating it down the river in flats to the rail road bridge across the Coosa, whence it was carried by rail to Montgomery and Selma. This coke was said to be the finest ever made in the State, and to equal the very best English cokes.

There are three seams known, the thicknesses of which are three feet, four feet, and three and a half feet.

The proximity of these fields to the vast deposits of iron ore along the Selma, Rome & Dalton R. R., as well as to those lying between the rail road and the river, along Choccolocco creek, and also to the beds at the very edge of the fields themselves, makes it highly important that an early and thorough survey of them should be made.

The probabilities are that the supply of fuel for working up these iron deposits east of the field will be derived from these beds. A rail road twenty miles long would open them to the world.

WARRIOR FIELDS.

The immense extent of this great basin, estimated to contain at least 5,000 square miles of coal rocks, the comparative wildness of the country, and the fact that systematic explorations have been confined to the southern and eastern edges of the field, make it impossible to note anything more than those developments which have been made along the rail roads which skirt the eastern and southern edges of this area.

Proceeding north from Birmingham, a distance of nine miles, we enter the Warrior Coal Basin. At this point the Newcastle Coal and Iron Company's mines are situated.

Newcastle Coal and Iron Company.

This Company was organized in 1873. A slope was sunk upon the Milner or Newcastle Seam, 600 feet in depth. This slope has a double track, and also a man-way and pump-way. The coal is hoisted by means of an engine of 20 horse power; the water by a steam pump. The dip of the seam is about 5 deg. to north-west, flattening as we continue down the slope. There are two lifts; the average thickness of the seam is five feet eight inches. The coal is in three benches; the lower bench is twenty-eight inches thick, followed above by six inches of slate, then by a stratum of coal averaging six inches in thickness, then another layer of slate from two to six inches thick, and then another fine bench of coal twenty-eight inches in thickness. The roof of the mine is exceedingly good. At present the mine is worked by hired labor, although convict labor has hitherto been employed with success. The method of extracting the coal, is to bear in between the two benches, throwing the slate to the rear, then allowing the upper bench to fall across the whole face of the room, and lifting the lower bench by means of wedges. This mine has the largest capacity of any in the State, and could easily turn out 300 tons per day; 60 tons per day being extracted at this time. A test slope was also sunk upon this seam, a few hundred yards south of the main opening, to a depth of 230 feet, the seam proving precisely the same there as at the main opening.

The outcrop of the seam is on the western side of the rail road, and about twenty feet above the track.

The Company owns about three miles of outcrop along this seam. The difficulty of keeping the coal free from shale has, to some extent, impaired its value.

Washing the coal would free it from this shale, and from any pyrites that might be found in it, and the cheapness with which the coal can be mined would render the erection of machinery for this purpose practicable.

A very fair quality of coke has been made from this coal, without washing. On the opposite side of the rail road, a few hundred yards south of the Newcastle mine, the Company has opened the Black Creek seam. This is reached from the rail road by a tram-way 1,200 feet in length; the immediate approach to the seam is through a tunnel driven through the top rock of the seam, 100 feet in length. Gangways are turned north-east and south-west along the seam; the coal is worked in rooms twenty-five feet in width, upon what is known as the *pillar and stall* system; the average thickness of the seam is two feet ten inches clean coal, and the "lift" averages 350 feet, gained by this tunnel; the dip is the same as that of the Newcastle seam. The seam is underlaid by soft fire clay, which enables it to be under cut and wedged down without the use of powder. The roof is fire clay, and is noted for the immense quantity of beautiful fern impressions contained in it.

This coal having a large percentage of fixed carbon, is an excellent blacksmithing coal; for gas making it is pronounced equal to Pittsburgh coal; tests made with it at the Nashville gas works show a yield of 4.95 cubic feet of gas per pound—lump coal being used. Its evaporating power is stated to be 8.10 pounds of water to the pound of coal. The Company is utilizing the slack by making it into coke, which brings twelve cents per bushel at the mines. The mine is worked by convict labor, which has proved satisfactory. The output at present is 70 tons per day.

Jefferson Coal Company.

This Company started in the spring of 1874, on what is known as the Jefferson seam. The mine is located in S. 36, T. 14, R. 3, W., about ¼ of a mile south of the rail road bridge across the Warrior river. It is owned and worked by Messrs. Myer, Morris & Co. An extensive side track has been put in, fine shoot erected, and an engine and pumps of the best kind provided.

The mouth of the mine is about seventy-five feet below the track; an inclined plane has been built to the mouth, and a

slope continued through the sandstone rock to the seam. The coal lies nearly horizontally, rising slightly to the east, it being in the basin, and this is the only mine worked in the basin proper, the other being upon the outcrop.

The seam is nearly three feet thick. Operations were suspended here in September, 1875, with a view of sinking a shaft near the rail road in order to work to better advantage, as during freshets back-water from the Warrior river reached the mouth of the slope. While in operation, the company mined about 5,000 tons of coal.

The Black Creek seam is supposed to be about sixty feet below this—the Warrior seam underlying the Black Creek.

The Company owns 300 acres of land in the basin.

Mines at Warrior Station.

After crossing the Warrior river, we find ourselves on the northern edge of the basin.

Mr. James T. Pierce, upon the completion of the S. & N. Ala. R. R. in 1872, commenced operations upon the Warrior seam, at a point one mile north of the Warrior station. The seam here dips slightly to the south, and drifts are run in all along the outcrop. The output has been from thirty to fifty tons per day up to the past summer (1875), when a side track, half a mile in length was put in by the rail road company, and eight or ten new openings made. The coal is used by the rail road company in their engines and is an excellent steam coal. The present production is over one hundred tons per day, (on December 14th, one hundred and fifty tons were mined and shipped). The seam varies from two to two and a half feet in thickness, and has a good roof; the coal is rather soft, but excellent for blacksmithing purposes.

Near the station, and on the western side of the rail road, two other mines are located upon the same seam. Both were opened in 1873—the one by Mr. O'Brien, the other by Messrs. Moss and Hogan. These parties worked the mines, producing from twenty to thirty tons per day each, until the spring of 1875, when their mines were purchased by the Alabama Mining and Manufacturing Company. Extensive im-

provements have been made by this company, a long tram way built, an excellent shoot erected, &c. The present production is seventy tons per day.

Before leaving this part of the field, it may be of interest to notice that a short distance above where the rail road bridge crosses the river, coal was mined from the bed of the river as long ago as 1836, and carried by barges down to Mobile. Mention of these early operations will be found in the Reports of Prof. Tuomey.

It remains now to speak of the mines along the A. & C. R. R. Very little has been done here, and no accurate information has been obtained. There are, however, mines at Clements' Station, Caldwell's Station, and one other point in this vicinity. The coal is obtained by means of drifts, and is hauled by wagons to the rail road, where the openings are not immediately upon the road. The seam at Clements' is said to be two feet thick, and is a fair article for domestic use. The amount produced will probably not exceed 2,000 tons per annum. The coal at Clements' Station is obtained from sections 1 and 2, township 22, range 8 west, and hauled about a mile to the rail road.

In the vicinity of Tuscaloosa, coal has been mined and used by the inhabitants for more than forty years. For an account of the earlier operations here, the reader is referred to the Reports of Prof. Tuomey.

There are no mines here at present, that do more than supply the local demand.

Upon lands belonging to the Insane Hospital, a shaft over sixty feet deep has recently been sunk by Messrs. Keene and Finley of Tuscaloosa.

In 1873 a company was organized under the name of the *Tuscaloosa Mining and Transportation Company.*

A large number of Welsh miners came out from Pennsylvania. Considerable prospecting was done in the vicinity of Hurricane creek, a tributary of the Warrior; but the company has never gone into active operation.

Below we give an extract from a report upon these lands,

made by Prof. N. T. Lupton and the present State Geologist, Dr. Smith. Some of the most instructive of these local outcrops are given in the sections following:

Section 1 is on north-east corner section 9, township 20, range 7, west.

Section 2 is on south-west corner section 18, township 20, range 7, west.

The two sections are given side by side:

	I.		II.	
Shale and Sandstone	——	7 feet 8 in.	——	9 ft. 8½ in.
Coal	13 inches		17 in.	
Shale	3 "		2 "	
Coal	9 "		9½ "	
Shale	2 "		1½ "	
Coal	7½ "		10 "	
Shale	2½ "		½ "	
Coal	15 "		12 "	
Fireclay part'g.	22 "		36 "	
Coal	19 "		28 "	
Fireclay	——		——	

In section I, (7 feet 8 inches,) there are 5 feet 3½ inches of clear coal. The coal from this outcrop is well known to Tuscaloosa to be good, as it has been carried to market there. The lowest stratum, 19 inches, furnishes the best coal, which is very firm, though so much exposed.

In section II, there are 9 feet 8½ inches, with 6 feet 4½ inches of clear coal. This exposure was made by the miners, and has been worked for coal.

The close correspondence in the succession and thickness of the different strata, leaves very little doubt that we have here two sections of the same coal seam.

In the case of the other coals whose outcrops we examined, it was impossible to obtain the data sufficient to enable us to give, with absolute certainty, a section which would represent the succession of the different beds in a vertical direction; with one exception, which is given in sections III, and IV below; thus, on section 27, township 20, range 7,

west, on a small branch, tributary to Hurricane creek, we obtained the following:

III.

Sandstone roof............	——	3 feet 2½ inches.
Coal......................	20 in.	
Shale.....................	1 in.	
Coal......................	7½ in.	
Shale.....................	1 in.	
Coal......................	9 in.	
Fireclay..................	——	

Three feet 2½ inches, with 3 feet ½ inch clear coal. This coal is also known to be of excellent quality, as it has often been sent to the market in Tuscaloosa.

On the same branch, some distance further down stream, and about fifty feet vertically below, is another seam, of which the following is a section of the outcrop:

IV.

Sandstone roof..............	——	2 feet 9½ in.
Coal........................	19½ in.	
Shale.......................	1 in.	
Coal........................	13 in.	
Fireclay....................	——	

Two feet 9½ inches with 2 feet 8½ inches clear coal, the quality of which is likewise excellent.

Here we have undoubtedly two distinct seams of coal, separated by about 50 feet of intervening strata—each seam with a good sand-stone roof.

As the character of a seam of coal over limited areas, is in general, remarkably constant, sections I and II, in our opinion, represent another distinct seam, though the means for the absolute determination of this point was not at hand.

Another outcrop V, (section 19, township 20, range 7, west,) showed 28 inches of clear coal, without shale, and in section 1, township 21, range 8, west, is another exposure, VI, of about 36 inches clear coal. Coal has been mined from both these outcrops, and sent to Tuscaloosa, and its good qualities have been sufficiently well tested.

From the enclosures of the coal, and its quality at the two exposures, we consider them to be sections of the same seam,

the position of which is probably between the seam represented by sections I and II, below it, and that represented by III above."

II. Geological Features of the Fields and Character of the Coals.

CAHABA FIELDS.

A most accurate and thorough survey of the southern part of these fields was made some years ago by Mr. Joseph Squire, of Helena, Ala. A map embodying the results of this survey, was drawn by Mr. Squire, and it is the basis of all the maps of this region now extant. We hope to publish this map at an early day.

The extent of the country examined, its roughness, (it being covered by an unbroken forest,) the almost complete absence of any accurate information concerning the field, made the survey extremely difficult. It is, indeed, a monument of patient and accurate work, and Mr. Squire deserves the greatest credit for the manner in which he has carried it out. As we cannot reproduce the map here, at this time, we will indicate the positions of the different series of coal seams, with sufficient accuracy to enable the reader to lay them down for himself.

Upper or Montevallo Group.

The seams of this group are found on the southern and south-eastern edge of the Cahaba field; they dip at a high angle, (nearly vertically,) towards the south; but there is also a small basin, known as the Montevallo basin, formed by several of the lowermost seams of this group.

The highly inclined series begins in the south-west $\frac{1}{4}$ of S. 19, T. 22, R. 3, west, runs in a southwesterly direction for about three miles to the SE. $\frac{1}{4}$ of S. 2, T. 24, R. 11, E., thence due west for 3 miles to S. 5, then turning a little towards the south-west again, they disappear near Alligator creek. A small patch, of a still higher series, is found in sections 5 and 6 of T. 24, R. 12, east; but these seams are too close to the

great fault which cuts off the coal measures, to be of much value.

Lower or Cahaba River Group.

The seams of this group, from the lower end of the field up to Helena, follow in general the course of the Cahaba river, *i. e.*, north-easterly, being mostly found on the south-eastern side of that stream.

A survey of this part of the fields, was made by Mr. Richard P. Rothwell, one of the editors of the Engineering and Mining Journal, published in New York. The results of this survey were presented in a paper read before a meeting of the American Institute of Mining Engineers, held at Easton, Penn., in October, 1873, and subsequently published in their transactions.

This is the best account of the Alabama coal fields which has yet been made public; we have, therefore, requested and obtained from the author, permission to reproduce it here.

ALABAMA COAL AND IRON.

BY RICHARD P. ROTHWELL, M. E.

A reference to the geological map of Alabama shows the coal measures of that State to form three distinct fields. The Coosa, or most easterly, contains about 100 square miles; the Cahaba, or middle field, which is also the most southern true coal in the United States, contains about 230 square miles and the Warrior field, which contains in the State of Alabama some 5,000 square miles, is the southern extremity of the great carboniferous deposit, which extends through Pennsylvania, West Virginia, Kentucky, Tennessee, and Georgia.

But very little has yet been done towards developing these coal fields, partly owing to the absence of all commercial manufacturing enterprise in the South under slavery, and partly owing to the want of capital and the disturbed condition of the South since the war.

During the past three or four years I have devoted a large part of my time to the examination of the coal and iron ores of this range, and particularly to the coal in the Warrior and Cahaba fields, and the iron ores which are found in such abundance in their vicinity. My surveys and examinations have been directed especially to the Cahaba field, which, from its geographical position as the most southern coal in the State, and the most accessible by water communication, counting the Alabama river as the only available stream at present, and on account of its presenting the greatest variety, and, I believe, the best quality of coal easily accessible, will undoubtedly be the center of a large industry, and must, in the near future, become one of the principal coal producing districts in America. * * * * *

* * * No developments of any value have been made in the Coosa field, beyond proving the fact of the existence of several workable beds of coal, which were exploited some years ago for the supply of the blacksmiths in the vicinity.

The Coosa river could be made navigable only by a large expenditure of money, building locks and dams, and the coal basin is not crossed by any rail road. The Selma, Rome & Dalton Rail Road passes near the southern edge of this field, and the South and North Alabama road follows up the limestone valley, which lies between this and the Cahaba field.

At the base of the coal measures in Alabama, as in other portions of this country, we find a series of hard, coarse-grained, heavy-bedded sandstones. They do not, however, resemble the conglomerate we find at the base of our anthracite coal measures, nor are they even as coarse as the sandstones which lie below the West Virginia coals, on the Sewell mountain and the New river, but they have the same effect upon the topography of the country; for being much harder than the rocks immediately containing the coal beds, they form a well defined ridge, running in an almost straight north-east and south-west line, as the western limit of the Cahaba field.

The dip of these rocks does not usually exceed twelve de-

grees, and is frequently less than ten. Crossing the field in the direction of the dip, (*i. e.*, south-east,) and limiting our remarks to the southern portion of the field, where the measures are regular and the width of the field greatest (about twelve miles), we note that the inclination of the measures increases from six to ten degrees on the western limit, to twelve or fifteen degrees on the Cahaba river, in the vicinity of the Lily Shoals, and from that to the eastern limit of the field the dip increases much more rapidly, though still with tolerable regularity, till along the eastern edge of the field the rocks are dipping from 45 to 75 degrees, or even vertical in a few places, the dip being constantly in a south-easterly direction. The Cahaba coal field is limited on its southern and eastern sides by a fault which cuts off the coal measures, and brings to the surface, on a level with the highest coal beds of the field, Silurian rocks* which belong fully 7,000 or 8,000 feet below them. The vertical displacement of this enormous throw or fault must, therefore, be but little less than 10,000 feet, or nearly two miles. I know of no other such fault in any other part of the world.

The Silurian rocks, which have also a steep southeast dip, are for the most part limestones, metamorphosed by the action of the agents which caused this great rupture of the earth's crust, and cherts, which evidently have replaced limestones, and are, in many places, pseudomorphs of calc spar, and contain occasionally characteristic silurian fossils. * * In hardness, these rocks do not vary greatly from the softer sandstones, and coarse and loose pebbly conglomerates which here constitute the higher coal measures, and we do not, therefore, find any very marked ridge along the southern and eastern sides of the field as we do on the west, and as we would find, were this field really a true trough-shaped basin, instead of being a monoclinal basin as it is. This very remarkable feature exerts a notable influence in the economic value of the field. In the first place, we have here a much greater thick-

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* The Silurian rocks thus brought up to the level of the coal measures belong to the subdivision known as the Knox Sandstone, probably the equivalent of the Calciferous Sandstone of northern States. E. A. S.

ness of measures than exists anywhere along the eastern [western? E. A. S.] side, and probably in any part of the great Warrior field, which is a true trough-shaped basin, with a very moderate inclination of the measures. The greater inclination of the Cahaba beds causes them to outcrop within a limited area, and as we have here a greater total thickness of measures, so we have a greater number of coal beds, and, consequently, a greater variety of coals than, I believe, exists in any part of the Warrior or Coosa fields.

It is true, however, that there is more coal which can be worked *above water level* in the Warrior field than in the Cahaba, though, since in either case the hills rarely rise more than 150 to 200 feet above the level of the creeks, no very large amount of coal will be obtained level free. From the topographical features of the country, a rail road crossing the southern portion of the Cahaba field would be graded at a considerable elevation above the streams, the coal would have to be raised either in shafts or on planes to the level of the rail roads; there would, therefore, be the less inducement for opening mines on the lowest water level, except, of course, drainage levels. The small inclination of the beds would make it necessary to open all the lower beds by means of vertical shafts, which would be located with reference to shipping facilities on the railways. The surface of the field is very broken, valleys being cut in every direction. It is an exceedingly difficult country in which to select the most desirable route for a road; not that there are any insurmountable, or even very great, obstacles to the construction of a road with moderate grades and good alignment across the southern portion of the field, but, since the road should be built with the special object of developing the coal mining interests, it should run in that portion of the field where the largest beds and the best quality of coal is accessible at moderate depths, and where the regularity of the measures gives promise of freedom from those faults and disturbances which are so serious a drawback and source of expense in coal mining operations. These are considerations which appear to have been overlooked in the location of all the Alabama rail roads.

The surface of these coal fields is nearly everywhere covered by a virgin forest of yellow pine, oak, chestnut, and other valuable timber. The soil is light, and not suitable for agricultural purposes, except in the river and creek bottoms, which are of very limited area. * * * * * *

NUMBER AND THICKNESS OF THE COAL BEDS.

The coal measures of the Alabama fields consist of a series of sandstones, conglomerates and shales, among which we find some ten or twelve veins of workable thickness, *i. e.*, from two feet, (average thickness of clean coal,) upwards, besides a number of smaller beds, several of which are from fifteen to eighteen inches in thickness. These ten or twelve workable beds are distributed in two series or groups, as we find in all our coal fields, notably in West Virginia, Ohio, and Pennsylvania. The lower group contains seven or eight workable beds, varying in average thickness from three feet to seven feet of clean coal, and making an aggregate thickness of workable coal in the beds thus far proved of from thirty to thirty-five feet, while the upper or Montevallo series, which occupies but a very small area along the eastern side of the field, contains some three or four workable beds, giving an aggregate thickness of about twelve feet, making the total thickness of coal in the field, in beds of workable size, at from forty to fifty feet.

The enormous thickness of measures which exists between the lower beds of the lower series and beds in the Montevallo or upper group, renders the lower coals so deep as to be forever inaccessible where we have the upper beds—hence, the *maximum available thickness* of coal as yet proved in any portion of the field will not exceed thirty to thirty-five feet; while, if we take the area of the Cahaba field at 230 square miles, the average thickness of workable coal over the entire field would probably scarcely attain fifteen feet; for in a great part of the field along the western side, where the measures are nearly horizontal (5 deg.—10 deg.) there are but two workable beds. This estimate, so much lower than we have been accustomed to see stated in reports and newspaper arti-

cles, is probably not very different from the thickness which the same method of estimating would give for any of our other bituminous coal fields.

Without describing in detail the peculiarities of the different veins, which would be out of place in a general paper of this kind, though of very great importance in determining on the establishment of mines, I may say that the veins of the Cahaba coal field are generally free from shale partings, that is, they form generally a single bench of coal, and in that respect will be found better adapted for clean mining than most of the beds of the Warrior field, where some of the larger veins have a number of shale bands running through them. The thickness of the largest bed, as yet proved in the Cahaba field, is about nine feet, but where examined, two feet of these nine formed a shale band, leaving the coal in two divisions of about five feet six inches, and one foot six inches; where, unfortunately, the thick bench comes on the top, the probability, therefore, is, that the lower bench will be abandoned.

Another vein, worked to some extent during the war, is represented to have a thickness of seven feet of clean coal. The good quality of the coal from this place is quite evident, for there still remain at the pit-head several hundred tons of it in large lumps, which have resisted very successfully the action of the atmosphere for some eight years now, having been all that time exposed to the sun and rain of a warm climate; and it is still so serviceable a fuel that many of the farmers send for miles to get it for their winter supply.*

The accompanying sections, one across the southern or widest portion of the field, the other across the basin on the line of the South & North Alabama Rail Road, will give the general features of this field, and show the remarkable fault which limits the coal field on the south and east.

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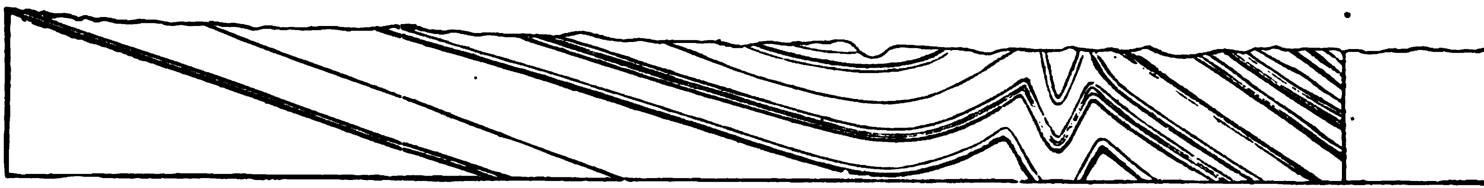
* The two seams here mentioned, are the Big Seam, and the Gholson Seam, Thompson's Lower Mine on the latter, being the one specially referred to.

E. A. S.

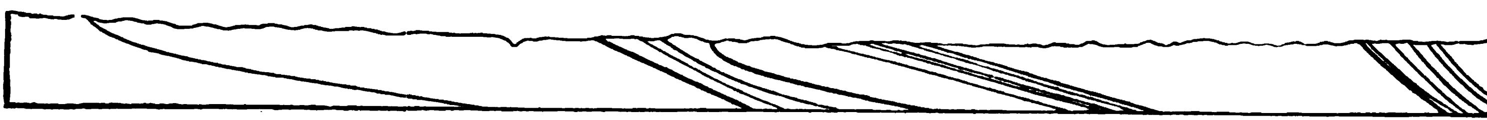
CAHABA COAL FIELD.

SECTION ON S. & N. R.R.



SCALE ½ MILE TO AN INCH.

SECTION ON FOUR MILE CREEK.



SCALE .1 MILE TO AN INCH.

The South & North Alabama Rail Road section shows, also, one of those peculiar contortions in the rocks which we frequently find in the coal fields; it is very well defined at this point, and has the effect of greatly interfering with mining operations, for such plications are the results of a crushing of the measures which makes the coal faulty and not unfrequently sulphury, even at some distance from the anticlinal and synclinal axes.

In general we may remark that wherever the disturbance of the measures is so great as to leave the beds standing at a high angle, say 60 to 80 degrees, or vertical, we almost invariably find the veins are subject to great irregularity, both in the thickness and hardness of the coal; they are, in short, "faulty," and this is as true in the anthracite as in the bituminous fields. The rolls which we find in the narrow, compressed part of the field where the South & North Alabama Rail Road crosses, disappear, or at least, so diminish in importance in the southern portion of the field that they cannot be designated as anticlinals, for they do not divide the field into separate basins. On the "Four Mile Creek" section to which I refer, these rolls barely change the degree of the dip over a very limited distance from, say twenty degrees to horizontal, or nearly so. Undoubtedly they will exert an influence on mining operations, even though they are not of such magnitude as to divide the field into different troughs or synclinal basins; their position in the field, especially in that portion of it where the most desirable coals are accessible, has received much attention in examination, but to name these points without reference to an elaborate map would be of little interest.

The following are the workable beds proved on or near the line of the South & North Alabama Rail Road. I place them in their order of superposition, commencing with the highest, the thickness being the average of clean coal where examined:

*No. 9.	Thickness.	.4 ft. 0 in.	No. 4.	Thickness.	.3 ft. 6 in.
" 8.	"	..3 ft. 6 in.	" 3.	"	..3 ft. 3 in.
" 7.	"	..2 ft. 0 in.	" 2.	"	..4 ft. 0 in.
" 6.	"	..2 ft. 0 in.	" 1.	"	..3 ft. 6 in.
" 5.	"	..2 ft. 6 in.			
Aggregate thickness					.....28 ft. 3 in.

It is true that at this point the measures are compressed, and these veins may become thicker as we get some distance away from the line of the greatest disturbance, in fact, in the southern portion of the field, we find the beds much larger, there being but little disturbance there. The developments thus far made are not sufficient to enable us to identify the beds in different parts of the field, but I give an approximate section of the measures in the "Four Mile Creek," as follows:

†4 veins Montevallo Group, ag'te	12 ft. 0 in.	V	vein,	3 ft. 6 in.
VIII vein	3 ft. 6 in.	IV	"	8 ft. 6 in.
VII "	7 ft. 0 in.	III	"	3 ft. 6 in.
VI "	4 ft. 0 in.	II	"	4 ft. 0 in.
		I	"	4 ft. 0 in.
Total				50 ft. 0 in.

There are probably other workable beds not yet known. We can assume the thickness of coal in the southern portion of the field at 35 to 40 feet in the lower group, and about twelve in the upper group.

The great fault, which limits this coal field on the east, has left none of the upper groups of coals, and, probably, not

*For the sake of reference I give below the names of the Seams corresponding with the number given by Mr. Rothwell. T. H. A.

No. 9. Helena Seam.	No. 5. McGinnis' or Black Shale Sm.
8. Conglomerate, or Beaver Dam Seam.	4. Buck Seam.
7. Little Pittsburgh Seam.	3. Cahaba Seam.
6. Moyle Seam.	2. Cahaba Seam.
	1. Gould Seam.

†The names of several of the veins, corresponding to the above numbers, are given for convenience. T. H. A.

VII vein is at Thompson's Lower Mine on the Gholson vein.

VI vein is Gholson vein at Daly's Creek.

V vein is the Coke vein.

IV vein is the Big vein.

even the two highest veins of the lower group, on the line of the South & North Alabama Rail Road.

While our data are not sufficient to identify the several beds in the different parts of the field, yet the dimensions of the veins I have above given are from openings made mostly during the war, when the needs of the Confederate Government caused it to make extensive surveys and examinations of the field, (the notes of these were unfortunately destroyed during the latter part of the war,) and to open mines in a number of places.

The fact is, therefore, fully proven that Alabama possesses an abundant supply of coal in easily accessible beds of good workable thickness. I have made careful examinations of the quality of the coal of all the workable beds where it was possible to obtain satisfactory samples for analysis. I was unable in most cases to procure very large amounts of the coals, as would have been desirable; for the only manner in which to obtain samples whose analyses will give the average quality of the bed, is by taking a large number of freshly mined average specimens from the different divisions of the vein, and by crushing and mixing them previous to taking the samples for analysis. In some cases it was impossible to do this, so that, though care was taken to get what appeared average pieces, it is possible the run of the bed would not equal the analysis I have given. As a means of comparison with coals from other fields, the results will probably be satisfactory, for in most cases samples for analysis are taken in the same manner as were these, and the published results consequently indicate almost invariably a quality of coal superior to the average production of the mines. It is also essential that the coal be freshly mined, for experiments have been made that show that the deterioration which coal undergoes by even a very limited exposure to the atmosphere is quite considerable. For example:

According to Dr. Richter the *weather waste* of a coal depends upon its ability to absorb oxygen, converting the hydrocarbons into water and carbonic acid.

Grundman found that coal exposed for nine months to the

atmosphere lost fifty per cent. of its value as a fuel. He states that the decomposition takes place in the middle of a heap the same as on the surface, and it reached its maximum about the *third* or *fourth* week; and one-half the oxygen was absorbed during the first fourteen days. He also found that a coal poor in oxygen absorbs it most rapidly, and that the presence of moisture is an important condition. Coal which made, when freshly mined, a good compact coke, after eleven days exposure, either would not coke at all, or it made an inferior coke. For gas purposes the coal is also greatly injured by the loss of its volatile hydro-carbons.

VARRENTRAPP, of Brunswick, found in his experiments that oxidation of the coal takes place even at common temperature, where moisture is present. Coal exposed to a temperature of 284 degrees, Fah., for three months lost all its hydrocarbons, a fact which shows that the conversion of bituminous coal into anthracite was not necessarily accompanied by a high temperature. He found, also, that the weather waste in some cases amounted to thirty-three per cent., and in one instance the gas-yielding quality decreased forty-five per cent., and the heating power forty-seven per cent., while the same coal, under cover, lost in the same time, but twenty-four per cent. for gas purposes, and twelve per cent. for fuel.

The harder varieties of bituminous coal, such for example as the cannel and splint coals of West Virginia, Ohio, and Indiana, do not appear to lose much by exposure to the atmosphere, except it be in heaps of slack where the conditions are favorable to the generation of a high temperature. Anthracite appears to be still less affected by exposure, for the fine coal which has lain for the last twenty years in our culm banks, exposed to the rain, and under conditions the most favorable for decomposition, being mixed with shales containing a large amount of iron pyrites which in decomposing generate a very high temperature in the whole mass, is yet found to burn well, almost as well as that freshly mined, while the large lump coal has been used in our blast furnaces after an exposure of twelve years, and no perceptible difference in its quality could be noticed. It is nevertheless quite certain that

most varieties of bituminous coal deteriorate very rapidly, and to an extent but little appreciated.

These important results should be borne in mind, not only in providing for the storage of coal, but also in selecting samples for analysis.

The following table gives the composition from some seven or eight different beds. (The numbers of the samples and the beds from which they are taken are given on the same page. T. H. A.) These analyses, made with much care, will be found of value and interest, and though only a part of those I have made, they may be taken as representing fairly the quality of the Cahaba coals:

CAHABA COALS—R. P. BOTHWELL.

	NUMBERS OF SAMPLES.										Mean of 10 analyses of Cahaba coals from 8 veins.	Mean of 14 analyses of Indiana coals.—Cox.	Mean of 6 analyses of Ohio bl'k coals. Newberry.
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.			
Specific gravity	1.22	1.29	1.29	1.38	1.29	1.28	1.12	1.28	1.25	1.35	1.26	1.24	1.266
Moisture	1.66	1.58	1.91	1.93	2.05	2.13	2.54	1.78	2.14	2.13	1.98	5.2	4.54
Volatile Combustible Matter	33.28	32.60	32.65	32.84	33.47	30.86	29 44	30.60	31.92	27.03	31.47	34 8	34.61
Fixed Carbon	63.04	62.62	63.91	59.64	62.20	64.54	66.81	66.58	63.68	66.22	63.92	57.2	58.68
Ash	2.02	3.20	1.53	5.59	2.28	2.47	1.21	1.09	2.26	4.62	2.63	2.6	2.17
Total	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.			
Sulphur as Sulphate	.097	.223	.071	1.001	.118	.320	.073	.085	......	.114	1.06	.. ...	0.87
Sulphur as Sulphuret of Iron	.428	.727	.559	2.779	.523	1.160	.455	.479	......	.388			
Sulphur in Coke	......	......	......	......	......	......	.214	.223	......	......			

"Connelsville Coke," Pa. .... 55 to 70 per cent.

Sample No. 1. From Cahaba Vein—Davis' Mine.
" 2. " " " Holt's Mine.
" 3. " Black Shale Vein—McGinnis.
" 4. " Moyle "
" 5. " Little Pittsburgh Vein.

Sample No. 6. From Conglomerate Vein.
" 7. " Helena "
" 8. " Coke "
" 9. " Gholson "
" 10. " Montevallo "

The above table shows that the Cahaba coals are of remarkably fine quality, being chiefly distinguished for their dryness, small amount of ash, and large amount of fixed carbon. We note particularly (as a subject worthy of further attention, and on which I desire to have the experience of other members) the regular increase, with but little exception, of the amount of moisture in the coal as we go from the lower to the higher veins; it would appear that, possibly, with a sufficient number of analyses of freshly mined coal, we might be able to determine the relative height in the series of the several veins of any given field, by this test alone. I believe it has been asserted that the quantity of oxygen in the coals of a given basin varies directly with the geological height of the vein. Unfortunately I was not enabled to apply this test, but it is a matter of great interest, if by careful analyses, we can determine the relative ages of coal beds of the same field, and possibly even of different fields.

Some of the above coals make an excellent coke suitable for blast furnace use, and as some of them are dry burning coals that do not coke, they would probably work raw in the furnace. Judging from the analyses alone, we would be inclined to consider all of the Cahaba as drier burning coals than those of Indiana or Ohio, while in reality the opposite is the case. The block coals of Ohio and Indiana, so largely used in the furnaces of the Mahoning Valley, do not coke in burning, while the Cahaba coals do, though the former contain about three per cent. more of volatile combustible matter, and nearly six per cent. less fixed carbon than the latter.

It is noticeable that these Indiana, and Ohio coals, ranked among the best furnace fuels we have in this country, contain on an average two and a half to three per cent. more moisture than the Alabama coals; in fact, the analyses would indicate that the Cahaba coal is a better fuel, and altogether an exceptionally pure coal. It has been fully proved as a steam generator, and the coke from several of the veins was used very successfully in the smelting of iron for the cannon foundry of the Confederate States, at Selma, during the war.

It may be found that it will be desirable in the case of a few

of the good coking seams to crush and wash the coal before coking, and this will be more necessary in the Warrior field than in the Cahaba, the veins proved in the former containing more soft shale partings which, in the mining, will break up and can not be separated from the coal.

The coals of the Warrior field appear also to be softer and more friable in general than those mined on the Cahaba.

The property which makes one coal cake or melt in burning, and another burn without change of form, is not to be determined by their composition alone, for we find coals almost identical in chemical composition, as are these Cahaba coals, and yet one cokes well, making a hard, compact, silvery coke, and another burns without change of form. It appears to me that probably in non-coking coals the carbon is in thin layers which are separated by exceedingly thin leaves of a carbon which has lost its volatile constituents. We not unfrequently find in the "partings" between successive layers of both bituminous and anthracite coal layers of charcoal—mineral charcoal, if we may so call it. And again, we know that on heating a piece of the hardest anthracite with the most perfect conchoidal fracture, we can readily distinguish under the microscope the original bedding planes of the coal, and can usually even divide the piece into leaves.

Now, where these leaves are separated by thin layers of what we may call oxidized coal—that is, coal which, from exposure, or other cause when being deposited, has lost a portion of its volatile constituents, bringing it to the condition of this mineral charcoal, it is probable the coal would not melt or cake in burning even where the amount of coal in the partings is so small that it would not change noticeably the composition of the entire vein, while where the bed was deposited in a continuous manner or without these partings of non-coking carbon, we would have a non-coking coal.

The Cahaba coals contain a small amount of sulphur, principally in the form of sulphuret of iron.

I have determined separately the amount contained as sulphate of lime, alumina, &c., since in that condition it is not supposed to exercise the injurious influence in the blast fur-

nace which it does when occurring as sulphuret of iron. The quantity of sulphur contained in these coals varies considerably, but the best veins are sufficiently free from it to be suitable for use raw in the blast furnace where the nature of the coal in other respects will allow of this, and in all cases they are so free of sulphur as to produce coke of great purity.

The cost of mining in the Cahaba and Warrior fields will vary for the different veins, according to their thickness, the amount of shales, interbedded in the coal, the nature of the roof of the vein, the location of the veins, and other conditions of a practical nature, which will require careful consideration for each particular case. For a large output the cost should not exceed $1.75 per ton in the rail road wagons, including in this, interest and wear and tear of improvements, but not royalties, for where the land can be bought at from $3.00 to $10.00 per acre, it is not necessary to count royalty or sinking fund for the property, the increase in the value of the surface much more than covering the first cost of the land. * * * * *

The concluding part of this paper, relating more especially to the iron deposits, we have omitted. T. H. A.

Through the courtesy of Mr. Walter Crafts, of the Shelby Iron Company, we are enabled to give additional details derived from Mr. Rothwell's report to that company, and we incorporate with the same information obtained from other sources.

Gould Seam.—The coal occurs in a single bench; thickness three feet six inches. It is soft, friable, and crumbles in handling, dull black in color, cokes well, is easily mined, but the roof is soft, and the seam irregular, often accompanied by considerable "mining."

Mr. Rothwell's analysis is as follows:

Specific gravity	1.30
Moisture	1.34
Volatile combustible matter	28.96
Fixed carbon	60.58
Ash	9.12
Total	100.00

Sulphur as sulphate	0.09	0.82, total S.
Sulphur as sulphuret of iron	0.73	
Sulphur in coke	0.21	

Cahaba Seam.—The average thickness of this seam is three feet; a fine coal, without shale partings. Cokes well, and is a good steam coal.—See tables for analysis. The Wadsworth Seam is stated by Mr. Rothwell to be identical with the Cahaba. I give below an analysis of the coal from the Wadsworth Seam, by Mr. A. W. Kinzie, of the Eureka Iron Works.

The *Buck Seam* is said to contain eleven to twelve per cent. of ash, but is a very good coal for domestic use.

The *Shortridge Seam* is omitted by Mr. Rothwell from his section. It is three feet six inches in thickness, without any shale partings, is an excellent coking coal, and will answer admirably for gas making. This seam lies below the Wadsworth seam.

Moyle Seam.—A careful section of this seam shows the following:

Top—Fire-clay.

Coal	0 ft. 3 in.
Fire-clay	0 ft. 5 in.
Coal	0 ft. 8 in.
Fire-clay	3 ft. 0 in.

Analysis given in tables above.

Conglomerate or Beaver Dam Seam. We have previously stated that this seam was extensively worked during the war. The seam is from three feet, to three feet six inches in thickness, but is quite irregular. It occurs in a single bench with a shale top; the quality of the coal is excellent. Analysis has been given in tables above.

Another analysis of this coal by Mr. Otto Wuth, of Pittsburgh, Pa., shows the following composition:

Water	0.30
Bitumen	31.36
Fixed carbon	65.45
Ash	2.81
Sulphur	0.08
Total	100.00

Helena Seam.—This seam has a good hard roof with shale bottom. It is the first seam belonging to the upper series above the conglomerate. The coke made from this coal is only average in quality. The extreme purity of this coal chemically, together with its structure, warrant the assertion that it would probably work raw in the furnace. The analysis is found in Mr. Rothwell's tables.

We have no more definite information of any particular interest, concerning the coals mined in the lower part of the Cahaba river group, than what has already been previously given, in our historical account, and in the reprint of Mr. Rothwell's paper.

Warrior Field.

There seems to be but little doubt that this field is composed of several basins; for want of proper explorations, however, their limits are almost entirely unknown.

The enormous thickness of the coal bearing rocks in the Cahaba field, being estimated at over 5,000 feet, has no parallel in the Warrior coal field.

We have very few analyses to give of the coals from this basin, except of those from the Newcastle and Black Creek Seams, and from seams in the vicinity of Tuscaloosa. For several of these analyses made for the survey by Prof. N. T. Lupton, the reader is referred to the Report of Progress for 1874.

An analysis of the coal from the Newcastle or Milner Seam, by Dr. Otto Wuth, of Pittsburgh, Pa., shows the following composition:

Specific gravity	1.38
Water	.50
Volatile matter	28.24
Fixed carbon	59.69
Ash	10.92
Sulphur	.64

See further, the remarks on this seam, made above in our historical account.

Of the Black creek coal, we present also an analysis made by Dr. William Gesner.

Black Creek Coal.

Specific gravity	1.36
Water.	.12
Bitumen (volatile)	26.11
Fixed carbon	71.64
Ash	2.03
Sulphur	.10
Per cent. of coke	73.67

"Its physical characteristics classify it as a firm bituminous block coal, with cubical cleavage, dull vitreous lustre, and very resistive to moisture."

The value of chemical analyses of coals is only comparative, their physical structure being of equal importance. We quote here some remarks by Mr. J. W. Foster, a well-known authority, illustrative of this point.

"It would appear that a furnace coal, to have sufficient reducing power, and at the same time all the softness and combustibility of wood, should have from 58 to 62 per cent. of fixed carbon, little moisture, and few impurities. There should be such a physical structure as to prevent the bitumen from running together in the process of combustion, and cementing the mass. With these coals a greater quantity of iron, in proportion to fixed carbon, is produced, than with anthracite; the quantity of iron better, and the wear on the furnace much less destructive. The peculiar propeities of iron-making coals, are dependent, not so much on the chemical qualities, as the physical structure, by which they are able to keep their form in burning."

"Analysis shows the materials of which a coal is composed, but not how they are put together. The heating power and intensity depend to a great extent on the mechanical structure."

The following approximate section of the strata in the vicinity of the Newcastle Iron and Coal Company's mines, was received from Mr. Thomas Sharp, the superintendent:

There are said to be two or three seams above the New-

castle; but the thicknesses and distances apart of these we cannot give.

Newcastle seam	5 ft. 8 in.
Sandstone	15 ft. 0 in.
Coal	0 ft. 22 in.
Fire-clay	3 ft. 0 in.
Sandstone	20 ft. 0 in.
Coal	2 ft. 6 in.
Sandstone	25 ft. 0 in.
Black band iron ore	1 ft. 4 in.
Sandstone	20 ft. 0 in.
Coal	4 ft. 9 in.
Sandstone	25 ft. 0 in.
Conglomerate	not passed.

The seam of black band iron ore, shown in the above section, is said to be of superior quality, and arrangements have been made by the Eureka Iron Company, for its use in their furnace.

III. Production—Markets and Methods of Shipment—and Future Prospects of the Trade.

No accurate record has ever been kept of the amount of coal mined in this State. From various sources, we have collated the following information upon this point:

Up to the beginning of 1874, we estimate the total production of the State at....................450,000 tons.

For 1874, the production was as follows:

S. & N. R. R. transported	33,139 tons.
S., R. & D. R. R. "	14,750 "
Transported over A. & C. R. R., and all other production (estimated)	2,000 "
Total for 1874	49,889 "

The production for 1875 we, of course, can not yet give; but there have already been transported over the various rail roads, up to December 1, about 65,000 tons. The total production of 1875 will probably show an increase over that of 1874, of at least 50 per cent.

The coal is transported by the rail roads to the markets, which are the principal cities of Alabama, Georgia, and Mississippi, and on the L. & N. R. R. as far north as Nashville, Tennessee.

The L. & N. and Great Southern R. R. Company is the largest consumer, using almost exclusively upon the southern half of the road, coal from the Warrior fields.

It is estimated that this company takes over 20,000 tons per annum of Alabama coal.

None of the furnaces as yet use coke in the smelting of iron; but the Eureka Company are making arrangements for its use as a fuel.

The rapid increase in the production and sale of coal of this year over last, shows that the future prospects of the trade are exceedingly favorable.

Since Cumberland coal is only $4.25 per ton at Locust Point, we can not expect to compete in foreign markets, unless we get our coal to tide-water cheaper. We can do this by shipping by rail to Montgomery and Selma, and thence to Mobile via the Alabama river. Mobile harbor has sufficient depth of water for coal-carrying vessels, and it has a great advantage over Pensacola, from the fact that return cargoes can be had to that port (Mobile).

This relieves the coal of the burden of paying freight both ways.

The writer apologizes for the fragmentary nature of this report; his purpose being only to collate and put in tangible form, notes upon the subject received from many kind friends, as well as those derived from printed articles.

A general acknowledgment is here made for the generous responses made to the writer's requests for information.

T. H. ALDRICH.

The following records of borings by a diamond drill, made in the Warrior Coal Fields in Jefferson county, are of such general interest that we reprint them here:

I. Drilling at Camp Branch, ten miles west of Birmingham, Jefferson County, Alabama.

		Ft.	In.	
1.	Surface soil and drift	4	0	
2.	Yellow sandstone	3	0	
3.	Clay or soapstone	6	4	
4.	Arenaceous clay	5	0	–18 ft. 4 in.
6.	Coal	0	10	
7.	Clay	0	6	–19 ft. 8 in.
8.	Coal	0	4	
9.	Clay, light	4	0	
10.	Gray sandstone, hard, micaceous	2	6	
11.	Coarse gray sandstone, fossils	53	4	
12.	Clay	1	0	
13.	Gray sandstone	6	0	
14.	Arenaceous clay	4	0	
15.	Clay	4	0	
16.	Arenaceous clay	6	0	
17.	Hard gray sandstone	2	0	
18.	Clay	3	0	
19.	Arenaceous clay, fossils, plants, etc	5	3	
20.	Blue sandstone, hard, micaceous	4	7	
21.	Variegated sandstone.	6	1	
22.	Arenaceous clay	4	0	
23.	Clay, with seams of coal through it	3	0	
24.	Soft blue clay, mud-vein	2	0	
25.	Gray sandstone, micaceous	14	1	
26.	Arenaceous clay	59	5	
27.	Gray sandstone, hard, micaceous	3	5	
28.	Clay or soapstone	7	0	
29.	Gray sandstone, hard, micaceous	16	0	
30.	Blue slate, pyrites, combined	100	7	
31.	Rippled sandstone, micaceous, tender	9	0	
32.	Gray conglomerate	7	0	
33.	Gray sandstone, micaceous	6	7	
34.	Dark gray standstone, hard, micaceous	4	0	–347 ft. 10 in.

35.	COAL, hard, bright, free from sulphur, as shown by core	6	0
36.	*Fire-Clay*	3	0
37.	Dark gray sandstone, fossils	5	4
38.	Fine sandstone, micaceous	33	0
39.	Arenaceous clay, filled with fossil plants	4	0
40.	Clay and mud	5	0
41.	Blue clay, fossils	11	0
42.	Light clay, fossils, ferns, etc	24	0
43.	Hard gray sandstone	8	0
44.	Coarse hard sandstone	2	0—449 ft. 2 in.
45.	COAL, (struck gas-vein, well flowing strong, gas on fire)	2	0
46.	Dark gray rippled sandstone, tender, micaceous	24	0
47.	Slate-clay sandstone, tender, micaceous	20	0
48.	Arenaceous clay, dark, good roof	4	0
49.	Clay, good roof	3	0—502 ft. 2 in.
50.	COAL, hard, glossy black	4	0
51.	*Fire-Clay*	2	0
52.	Clay, fossil plants	4	0
53.	Coarse gray sandstone, micaceous, bitumen	9	0
54.	Dark slate, coal plants	3	0
55.	Sandstone, soft, fossils	1	0
56.	Coarse gray sandstone, micaceous	3	0
57.	Soft conglomerate	2	0
58.	Soft gray sandstone, bitumen, coal-seams through it	4	0
		532	2

II. DRILLING AT WARRIOR FOR COAL, SOUTH & NORTH ALABAMA RAIL ROAD, JEFFERSON COUNTY, ALA.

		FT.	IN.
1.	Surface soil and drift	20	0
2.	Gray sandstone, micaceous	18	0

3.	Coarse sandstone, micaceous......	28	6	
4.	Dark arenaceous clay............	24	6	
5.	Clay or soapstone................	9	0	–100 ft. 0 in.
6.	Coal..........................	1	2	
7.	Clay, dark......................	30	0	-131 ft. 2 in.
8.	Cannel coal and black band......	2	4	
9.	Coal..........................	3	4	
10.	Clay..........................	4	0	
11.	Arenaceous clay.................	16	0	–156 ft. 10 in.
12.	Coal..........................	1	8	
13.	Clay, dark	1	6	
14.	Sandstone, micaceous............	3	0	
15.	Dark clay shale, coal plants......	3	0	–166 ft. 0 in.
16.	Coal, hard and free from sulphur..	2	2	
17.	Fire-clay, light..................	6	10	
18.	Soft micaceous rock....	9	0	
19.	Sandstone, micaceous, hard.......	6	0	
20.	Arenaceous clay.................	51	2	
21.	Dark fossil sandy clay............	48	6	
22.	Dark gray limestone, bitumen, hard.	10	0	
23.	Clay..........................	50	0	
24.	Arenaceous clay, rippled..........	4	0	
25.	Gray sandstone, micaceous, compact, seams of coal..................	6	0	
26.	Dark micaceous sandstone, slaty fracture......................	52	0	
27.	Clay, coal fossils.................	6	0	
28.	Hard, micaceous sandstone........	37	0	
29.	Clay or soapstone, fossil shells.....	3	0	
30.	Dark sandstone, fossil shells, pearly.	4	0	
31.	Dark clay, coal fossils............	2	0	–463 ft. 8 in.
32.	Coal, hard and bright............	1	6	
33.	Fire-clay.......................	1	0	
34.	Hard micaceous sandstone, gray...	15	0	
35.	Clay shale.....................	1	0	–482 ft. 2 in.
36.	Coal..........................	1	4	
37.	Arenaceous clay...........	7	0	
38.	Clay, coal plants................	5	0	–495 ft. 6 in.

		FT.	IN.	
39.	COAL, splendid	2	6	
40.	Clay	2	0	
41.	Micaceous sandstone	16	0	
42.	Arenaceous clay	6	0	
43.	Hard micaceous sandstone, gray	64	6	
44.	Clay or soapstone	9	0	
45.	Gray sandy shale, micaceous	5	1	
		600	7	

III. DRIDLING AT SULPHUR SPRINGS CHURCH, SEVEN MILES WEST OF BIRMINGHAM, JEFFERSON COUNTY.

		FT.	IN.	
1.	Surface soil	2	0	
2.	Dark clay	3	0	
3.	Sandstone, gray, micaceous, hard, fossils	16	0	
4.	Arènaceous clay	3	5	
5.	Arenaceous clay, fracture vertical	3	4	—27 ft. 9 in.
6.	COAL, soft	0	3	
7.	Sandstone, vertical fracture, pyrites	6	0	
8.	Dark limestone, vertical fracture, seams of spar, pyrites	8	0	
9.	Dark clay	25	9	
10.	Clay or soapstone, pyrites	47	0	
11.	Sandstone, traces of lime, (bastard)	2	0	
12.	Bastard limestone	1	0	
13.	Gray sandstone, hard, micaceous	2	0	
14.	Gray sandstone, coal seams through it	1	0	
15.	Clay pyrites, fracture vertical	3	0	
16.	Hard dark limestone	7	0	
17.	Hard sandstone, micaceous	4	0	
18.	Clay or soapstone, fossils	5	5	–140 ft. 2 in.
19.	COAL, good	4	6	
20.	Fire-clay	3	6	
21.	Gray sandstone, hard, micaceous	9	3	
22.	Arenaceous clay	9	6	–166 ft. 11 in.

23.	COAL, good	1	4	
24.	Fire-clay	1	6	
25.	Clay, fossils	8	0	
26.	Black limestone, very hard, (bastard)	2	0	
27.	Clay, fossils	17	3	197 ft. 0 in.
28.	COAL, and drillings of the coal	2	0	
29.	Slate clay	3	3	
30.	Clay or mud, seams of coal through it	3	0	
31.	Arenaceous clay, fossils	1	0	206 ft. 3 in.
32.	COAL, and drillings	1	8	
33.	Clay, fossils	1	9	209 ft. 8 in.
34.	COAL, and drillings, good	3	6	
35.	Clay	2	0	
36.	Coarse gray sandstone, fossils	23	0	238 ft. 2 in.
37.	COAL, sulphur balls	1	4	
38.	Arenaceous clay, coal plants	3	6	
39.	Clay or soapstone	1	0	
40.	Dark hard sandstone, micaceous	3	0	
41.	Arenaceous clay	2	0	
42.	Clay, coal plants	3	0	
43.	Dark arenaceous clay	28	0	
44.	Coarse, gray, sandstone, hard, micareous	6	0	
45.	Arenaceous clay	17	8	
46.	Clay, fossils, plants, etc	2	0	305 ft. 8 in.
47.	COAL	3	4	
48.	Arenaceous clay	1	0	
49.	Coarse gray sandstone	3	5	313 ft. 5 in.
50.	COAL mixed with clay	1	8	
51.	Arenaceous clay, seams of hard black slate	8	0	
52.	Coarse gray sandstone, seams of coal.	7	0	
53.	Dark sandstone, fine, coal plants	4	0	334 ft. 1 in.
54.	COAL	1	0	
55.	Clay, coal plants	2	0	
56.	Sandstone, micaceous	3	0	
57.	Clay	20	6	
58.	Coarse gray sandstone	6	0	

59.	Slate clay	13	0	—379 ft. 7 in.
60.	COAL, with seams of slate and sulphur	0	10	
61.	Clay, coal plants	2	0	
62.	Coarse gray sandstone, micaceous	9	0	
63.	Conglomerate	6	8	
64.	Arenaceous clay, fracture vertical	6	0	
65.	Dark gray limestone	4	0	
66.	Dark sandstone, shells	20	0	
67.	Arenaceous clay	10	0	
68.	Dark limestone, shells	3	0	
69.	Clay, with seams of sand, stones, (broken)	15	4	
70.	Dark gray sandstone, micaceous, hard	40	2	
71.	Dark sandstone, fossil plants	12	0	
72.	Dark limestone, hard	4	0	
73.	Arenaceous clay	30	5	
		543	0	

IV. DRILLING FOR COAL AT MORRIS STATION, JEFFERSON COUNTY, ALABAMA, S. & N. A. R. R.

		FT.	IN.	
1.	Surface soil, and soft red sandstone	5	0	
2.	Hard, gray sandstone, micaceous	20	0	
3.	Dark sandstone	5	0	
4.	Fossil clay	3	0	—33 ft. 0 in.
5.	COAL	0	8	
6.	Sandstone	30	0	
7.	Sand, clay seams, coal through it	17	0	
8.	Fine sandstone, dark	12	0	—92 ft. 8 in.
9.	COAL, soft	2	0	
10.	Fire-clay	1	0	
11.	Clay, coal fossils	3	6	—99 ft. 2 in.
12.	COAL, seams of sulphur	4	9	
13.	Fire-clay	1	4	
14.	Clay	4	0	

15.	Clay, hard	5	0	
16.	Arenaceous clay, bitumen	9	9	
17.	Gray conglomerate sandstone, hard	16	0	
18.	Slate	1	0	–141 ft. 0 in.
19.	COAL, mixed with slate	1	6	
20.	Arenaceous clay	2	0	
21.	Dark, fine sandstone, micaceous	6	0	
22.	Gray sandstone, hard, micaceous	7	0	
23.	Dark sandstone, seam of coal in it	3	0	
24.	Dark, rippled sandstone, micaceous	2	0	
25.	Gray sandstone, very hard	8	0	
26.	Clay or mud	1	6	
27.	Coarse, gray sandstone, micaceous	9	0	
28.	Slate clay	33	2	
29.	Clay	1	0	
30.	Clay, mixed with black slate	0	8	
31.	Light clay	8	0	
32.	Black slate	0	6	–424 ft. 4 in.
33.	COAL, very good, hard	1	6	
34.	Dark clay	3	0	
35.	Gray sandstone, dark micaceous	28	0	
36.	Fine, dark sandstone	7	0	–263 ft. 10 in.
37.	COAL, very good	4	5	
38.	Clay	3	0	
39.	Fine, gray sandstone, hard	5	2	
40.	Slate clay, fossil plants	21	1	–297 ft. 6 in.
41.	COAL, and drillings of coal, very good	2	6	
42.	Fire-clay	3	0	
43.	Slate clay	7	0	
44.	Gray sandstone, hard, micaceous	3	1	
45.	Slate clay	17	5	
46.	Gray sandstone, very hard	16	0	
47.	Buff limestone, very hard	3	0	
48.	Gray sandstone, hard	2	3	
49.	Slate clay	2	3	
50.	Dark, hard sandstone, trace of lime	3	0	
51.	Gray sandstone, micaceous, hard	2	0	

52.	Slate clay	15	0
53.	Dark limestone, fossil shells	4	0
54.	Dark sandstone	5	0
55.	Slate clay	18	0
56.	Gray sandstone, hard	8	0
		411	11

PARTIAL LIST OF COAL PLANTS

From the Alabama Fields, and Discussion of the Geological Positions of Several Coal Seams.

BY PROF. LEO. LESQUEREUX.

I. List of Species of Coal Plants, represented by the Specimens sent to me by Prof. Eugene A. Smith, State Geologist of Alabama.

1. Sphenopteris Hoeninghausi, Brgt. Helena, Shelby county, Ala. In numerous specimens.
2. Sphenopteris obtusiloba, Brgt. var. Helena, Shelby county, Alabama.
3. Sphenopteris trifoliata, Brgt. Helena, Shelby county, Alabama.
4. Sphenopteris elegans, Brgt. Helena, Shelby county, Alabama.
5. Sphenopteris (Eremopteris) artemisiæfolia, Brgt. Helena, Shelby county, Alabama.
6. Sphenopteris (Eremopteris) flexuosa, sp. nov. Helena, Shelby county, Alabama.
7. Sphenopteris (Eremopteris) crenulata, sp. nov. Helena, Shelby county, Alabama.
8. Sphenopteris (Eremopteris) dissecta, sp. nov. Helena, Shelby county, Alabama.
9. Sphenopteris (Eremopteris) trichomanoides, Brgt. Helena, Shelby county, Alabama.
10. Sphenopteris (Eremopteris) cristata? Brgt. Helena, Shelby county, Alabama.
11. Pecopteris (Aspidites) nervosa, Brgt. Helena, Shelby county, Alabama. Numerous specimens.

12. Sphenopteris amœna, sp. nov. Helena, Shelby county, Alabama.
13. Sphenopteris formosa, Gutb. Helena, Shelby county, Alabama. Same specimen as 14.
14. Sphenopteris Alabamensis, sp. nov. Helena, Shelby county, Alabama. Two large, very fine specimens.
15. Sphenopteris (Adiantites) nervosa, Brgt. Helena, Shelby county, Alabama. Small specimen.
16. Asterophyllites gracilis, Lsqx. Helena, Shelby county, Alabama. Good specimen.
17. Alethopteris Halliana? Lsqx. Helena, Shelby county, Alabama.
18. Lepidodendron squamiferum, sp. nov. Helena, Shelby county, Alabama. One very fine specimen.
19. Ulodendron minus, L. & H. Montevallo, Shelby county, Alabama. Fine Specimen.
20. Sigillaria, undeterminable from varnish. Montevallo, Shelby county, Alabama.
21. Stigmaria ficoides. Montevallo, Shelby county, Alabama.
22. Lepidodendron Weltheimianum, Sternb. Montevallo, Shelby county, Alabama. With leaves, fine.
23. Calamites approximatus, Schloth. Finley's Mine, Tuscaloosa, Alabama.
24. Sphenopteris latifolia, Brgt. Finley's Mine, Tuscaloosa, Alabama.
25. Neuropteris Smithii, sp. nov. Black Creek Vein. Fine species.
26. Calamites Suckowii, Brgt. Warrior Vein.
27. Staphylopteris asterioides? Lsqx. Warrior Vein. Very obscure specimen.
28. Asterophyllites equisetiformis, Brgt. Warrior Vein.
29. Whittleseya elegans, Newby. Specimens formerly sent without marked locality.
30. Cyclopteris? nobilis, sp. nov. One fine specimen, gray shale, without marked locality.
31. Cyclopteris? reniformis, Brgt. One fine specimen, and one poor, without marked locality.

32. Neuropteris subfalcata, sp. nov. Three or four fine specimens, gray shale, marked locality.
34. Neuropteris biformis, sp. nov. One specimen from Alabama; no locality given.
35. Cordaites principalis, Gein. Three specimens from Alabama; no locality given.
36. Asterophyllites equisetiformis? in fruit. One small specimen, from Alabama.
37. Asterophyllites equisetiformis? sterile. One poor specimen; locality doubtful.
38. Asterophyllites foliosus, Gein., sterile. One poor specimen; locality doubtful.
39. Trigonocarpus olivæformis, L. & H. One specimen; locality doubtful.
40. Rhabdocarpus carinatus? Newby. One specimen; locality doubtful.
41. Neuropteris Smithii, Lsqx. From Alabama.
42. Alethopteris Helenæ, sp. nov. Fine species; many good specimens. Helena Vein.
43. Alethopteris Lonchitica, Brgt. Two good specimens. Helena Vein.
43[a]. Lycopodites carifolius, Lsqx. On same specimen as 43.
45. Stigmaria ficoides, Brgt. Six specimens on sandstone; unknown locality.
46. Calamites ramosus, Brgt. One specimen. Alabama; (Helena Vein.)
47. Calamites cistii, Brgt., internal cast of. Locality unknown.
48. Calamites cannæformis, Brgt. Locality unknown.
49. Sternbergia approximata, Brgt. Three specimens, probably from Alabama.
50. Rachis of ferns. Two specimens, probably from Alabama.
51. Calamites approximatus, Brgt. One specimen from Alabama.
52. Calamites cistii, Brgt. One specimen from Alabama.
53. Calamites dubius, with stigmaria ficoides, and undeterminable Sigillaria; locality unknown.

54. Calamites Suckowii, Brgt. Large fine specimens in sandstone. Locality unknown.
55. Undeterminable Sigillaria. Locality unknown.
57. Lepidodendron sexangulare? Goepp. Dev. 1 specimen sandstone. Locality unknown.
59. Lepidodendron Weltheimianum. Sternb. 1 fine specimen gray shale. Alabama.

61 and 67. Branches of Lepidodendron, with leaves. Ala.

62. Lepidodendron and leaves, in sandstone, yellow. Ala.?
65. Lepidodendron leaves, very long. Four specimens, gray shale. Ala.
66. Lepidodendron branches and leaves. One specimen, gray shale. Ala.
68. Sigillaria monostygma. Lsqx. One specimen, gray shale. Alabama.
70. Lepidodendron marginatum. Sternb. One specimen, gray shale. Ala. Rare species.
71. Lepidophloios laricinus, Brgt., or L. obovatus, Lsqx. Gray shale. Ala. Rare species.
72. Calamites Cistii, Brgt. Gray shale. Ala.
73. Sigillaria? decorticated and undeterminable. Large specimen.
74. Rhabdocarpus clavatus? Sternb. Nutlet narrower, may be new; from Ala., mixed with Neuropteris Smithii.
75. Trigonocarpum Parkinsoni, Brgt. Specimen flattened; with Neuropteris subfalcata.
76. Trigonocarpum undeterminable. Same locality as No. 74; has N. Smithii.
77. Trigonocarpum Noeggerathi, Brgt. Gray shale. Same locality as No. 75; has with it Alethopteris Helenæ.
78. Tæniopteris Smithii, sp. nov. *A remarkable species*, of which it would be very desirable to know the locality.

NOTE.—In the above list, the numbers omitted were of specimens from other States.

E. A. S.

To Prof. Eugene A. Smith.

II. Remarks on the Geological Station marked by the specimens sent to me for examination and representing the species above named.

The first specimens sent to me were without labels; and, according to your remarks in your letter, were mostly from Alabama, though mixed with specimens from other States. A second lot of specimens was sent from Helena, Shelby county, Ala. These are numerous and well preserved; therefore of easy determination.

They may give hereafter a point of comparison for fixing the horizons of other beds of coal. In the same lot, I had a few specimen's from Finley's Mine, Tuscaloosa, representing only two species, one of which, *Calamites approximatus*, is presentin the whole extent of the Coal Measures, either above or below the Millstone Grit; and from the Warrior Vein a number of specimens, also representing three species only, one, *Staphylopteris asterioides? Lesqx.*, the specimen being too badly preserved for positive determination, and the others, *Calamites Suckowii* and *Asterophyllites equisetiformis*, two species also common in the whole thickness of the Carboniferous formation. Lastly, I received specimens from Montevallo, mostly undeterminable on account of the varnish; but representing at least two characteristic species—a branch of *Lepidodendron Weltheimianum*, and *Ulodendron minus*, not found elsewhere in North America; and in the same box two clay specimens from the Black Creek Vein, representing one species remarkable indeed, *Neuropteris Smithii.*

From this, it is clear that it would be impossible to look for an evidence of relation in regard to the stations of the different beds of coal wherefrom these fossil plants have been obtained, as none of the coal strata, except that of Helena, are sufficiently represented to afford points of comparison by their species. This only we have to acknowledge, that some specimens considered as yet of unknown locality, may be, by their determination, referred to their place of origin. As, for example, No. 41, *Neuropteris Smithii*, to the Black Creek Vein, like *Rhabdocarpus clavatus*, No. 74, which has also leaflets of

the same *Neuropteris;* and No. 75, *Trigonocarpum Parkinsoni*, from the same locality as No. 32, from the presence upon both specimens of the leaves of *Neuropteris subfalcata.* The distribution of fossil plants is not limited in homogeneous or special groups in each bed of coal of different horizons. The species peculiar to a locality, either stratigraphically or geographically considered, are few and always mixed with a number of others which may be called omnipotent, and are found, either in connection with a few beds related by groups, or in the whole thickness of the coal measures. For a determination of comparative stations between two or more beds of coal, it is therefore necessary to have a good series of specimens of each bed; for a comparison of groups, however, the plants of a single bed may afford sufficient evidence.

It is for a general comparison of this kind that we may obtain data, from the specimens of the Alabama coal measures, especially from those of the Helena coal bed.

The first examination of your specimens surprised me by this: that I recognized among them a number of forms which I had not seen elsewhere before, not only species, but peculiar types, differing from those with which I was well acquainted, from my continual explorations during more than thirty years in our North American coal fields. As these first specimens were not labelled, and as I found among them some old acquaintances from Tennessee, I did not dare to draw any conclusions, even supposing that you might have got specimens from Europe in your collection. The examination of the specimens from Helena put the matter in full evidence. For, in the specimens from that locality, we have in the greatest abundance *Sphenopteris Hoeninghausi*, which characterizes the lowest coal measures of England, the Culm of Germany, whose horizon is equivalent to the Sub-carboniferous limestone of the west; the Chester in Illinois; the first and second Archimedes in Arkansas. Of the same age are the species described by Brongniart as *Sphenopteris artemisifolia*, and the new species related to this form, *Eremopteris flexuosa*, *Eremopteris crenulata*, and *Sphenopteris amoena*, which, like the *Ulodendron minus* of Montevallo, have not been found as

yet in the coal measures above the Millstone Grit. Lower than this still, and related to species of the Upper Devonian, is *Adiantites nervosus*, Brgt.; *Asterophyllites gracilis* also, which I have first described from the Sub-conglomerate coal Arkansas, and which, more recently, has been described by Dawson from the Upper Devonian, of Canada, and by Andrew from the Waverly Shale of Ohio. Other species, *Alethopteris Halliana, Pecopteris nervosa, Sphenopteris trifoliata,* and *S. latifolia*, Brgt., are generally considered species of the low carboniferous of this country. And then we have from Montevallo, *Lepidodendron Weltheimianum* which ranges from the Sub-conglomerate coal to the middle of the Devonian; and from the Warrior basin, *Neuropteris Smithii,* which finds its analogues in European species described by Gœppert from the Upper Devonian. Now, add to this the number of new species, which, in twenty-six of which the localities are known, amounts to six, or nearly one-fourth, and this will give proof enough that the Coal Measures of Alabama are of a different stage from those of Tennessee, Ohio, Illinois, etc. In my Kentucky Report, I have remarked already upon sub-conglomerate coal measures, represented generally by two thin beds, two feet to four feet thick, distant from twenty to two hundred feet from the base of the Millstone grit. The coal of Arkansas is at the same horizon, and I do not doubt, that if I had been able to find there a larger amount of specimens of fossil plants, many of the species would have been identical with yours—one is, as was said above.

Years ago, I examined at Lebanon, Tenn., the collection of Safford, where I saw many species either identical with, or closely allied to yours, and from the statement of this geologist, his specimens came from under the conglomerate. Therefore, I believe that your coal measures are a branch in connection with that of North Kentucky, but especially with that of Tennessee. In the specimens whose locality is not marked, you have *Whittleseya elegans*, which has never been found before, but in one locality, Cuyahoga Falls, Northern Ohio, in a lower bed of coal, immediately above the Millstone Grit.

Cyclopteris reniformis is also of low coal. Indeed, except the few omnipresent species. Calamites and their branches, Asterophyllites, found everywhere, all your specimens point out characters of species of the lowest carboniferous measures.

All your new species are most interesting, and as my draughtsman has been absent some time, and will begin work again next Monday, I wish to have your specimens about six weeks longer, to enable me to have figures of all that is valuable. You may hereafter want this work for a report, or I may use it in the volume of the U. S. Coal Flora, now in preparation. Among these species, one has surprised me very much; it is the superposition upon the leaves of a species of Lepidodendron, which I have named *L. squamiferum,* of scales, round, square, and thick, though small, placed just at the base of the leaves. They are detached easily, and their characters are easily recognized. Nothing of this kind has ever been seen in Lepidodendron.

I should also remark, that though the specimens are undetermined in regard to locality, the frequency of *Sternbergia* in your carboniferous measures, indicates their old age. These stems are extremely common in the Upper Devonian coal of Canada; but as yet I have never found them in the coal measures of the North. * * * * *

My last observation is about the admirable richness of your coal flora, and the great value of its study to paleontological science. Could you have some of your assistants interested in the collection of specimens, at your different coal veins, I am certain that your State cabinet would become most interesting to study, than any of those which we have as yet in this country.

Very respectfully,

LEO LESQUEREUX.

Columbus, Ohio.

Modified Drift.

The low (Southern) part of Bibb county is covered with a superficial deposit of rolled gravel, sand, clay, &c., which hides entirely the underlying formations. The northern limit of the drift has been touched upon in two or three places in the details of Bibb county; but as the formation has not been made the subject of detailed study, this notice is given at this point merely for the sake of completeness.

Bibb County.

The portion of Bibb county, examined during the past season, is the southern extremity of the Cahaba coal fields, together with the narrow border of Silurian strata lying south and south-east of the coal fields.

The more detailed description of the coal measures, will be found in the article by Mr. T. H. Aldrich.

I propose here to give only a partial account of the Silurian rocks referred to; for the reason that the work which I had planned for the summer, was particularly the examination of the limonite or brown iron ore bearing belt, of this, and the counties lying north-east of it. The time has not been sufficient for a thorough examination of the whole Silurian belt.

The geological formations in this area, so far as they have been identified, are the following:

LOWER SILURIAN.	1. Calciferous or Knox Sandstone.	
	2. Quebec Group,	*a.* shale, (Knox Shale.)
		b. dolomite, (Knox D.)
	3. Chazy.	
	4. Trenton.	
UPPER SILURIAN.	5. Niagara.	
CARBONIFEROUS.	6. Sub-Carboniferous.	
	7. Coal Measures.	
	8. Modified Drift.	

1. Calciferous or Knox Sandstone.

I have noticed this rock only in one locality, viz: On Six Mile creek, in or near Section 36, Township 24, Range 10, east.

The following is a section of the rock there exposed; beginning below:

1. Shales, greenish; weathering buff....... 5 feet.
2. Heavy bedded yellowish sandstone......10 "
3. Greenish shales, breaking easily into small fragments......................... 4 "
4. Yellowish sandstone.................... 2 "
5. Shaly sandstone....................... 8 inches.
6. Blue shaly limestone, with seams of calcite, and showing a twisted or contorted texture............................ 3 feet.
7. Yellowish shales, alternating with beds of sandstone; thickness not known.

These beds are exposed in the bed of the creek where the weathering away and removal of the softer shales, ledges of the harder sandstone are left forming a series of natural dams. The strike of the rocks here is north-east and the dip south-east about 45 deg. The creek at this place flows north-west, so that the ledges of hard sandstone cross it at right angles. Although this formation has not been particularly identified elsewhere in Bibb county, there is no reason to doubt that it is to be found lining the north-west edge of the belt of shales next to be described.

From the character of the rock—hard sandstones, alternating with shales—it is found forming sharp ridges, which are, however, not very high.

In Bibb county, I have not noticed any fossils, or useful minerals in this horizon.

2 (*a*). Quebec, or Knox Shale.

Next in order above, and scarcely to be separated from the sandstone by any sharp line of demarcation, are the shales. The general character of these rocks has been given above in the General Geological Outline.

In Tuomey's Second Report the shales of this age are referred to on page 79. I give his remarks in full: "From Pratt's Ferry, a series of grayish red slates may be traced across the country to the Coosa. This forms the substratum

of a very remarkable soil, which differs materially from the soil of the clay slates of the primary rocks. The slates are inter-stratified with beds of limestone, the disintegration of which must have produced a decided effect upon the soils of this region."

The most southerly exposure of these shales noticed by me, was about five or six miles from Centerville, on the Montevallo road. From this place they trend in a north-eastern direction, and are seen again near the Shelby county line in S. 21, T. 24, R. 11, E., a mile or two west of the house of Col. J. Newton Smith. At this place the reddish brown and buff-colored shales alternate with limestones, sometimes shaly, and sometimes tolerably pure. Beyond this, into Shelby Co., the same belt may be traced, and at Montevallo it is seen in its best development.

The disintegration of the shale gives a clayey soil which is quite productive, but liable to suffer from dry weather. The interpolated beds of limestone add to the strength of the soil.

Of useful minerals, I have noticed none in Bibb county at this horizon, though in other counties small beds of limonite or brown iron ore are located here.

The limestones, especially the purer varieties, have been used in the manufacture of lime.

2 (*b*). QUEBEC, OR KNOX DOLOMITE.

From an economical point of view, this is by far the most important of the formations under consideration in Bibb Co., for it holds the banks of limonite or brown iron ore from which the blast furnace at Brierfield, and the bloomaries or Catalan forges of the past have been supplied.

This is the most extensive limestone formation, not only of this county, but probably also of the State.

The characteristic rock is a gray or whitish dolomite or magnesian carbonate of lime. In some places the dolomite is quite crystalline and pure, but oftener it is impregnated with siliceous matter. Occasionally it contains a sandy impurity which, upon the weathering away of the rock, becomes

quite prominent. The siliceous matter, however, is found in the dolomite usually in concretionary masses, and the *chert*, as it is called, forms the angular flinty gravel which covers the ridges of this formation. Owing to the prevalence of siliceous matter in the rock, it forms ridges rather than valleys, and the chert which covers the hillside is quite characteristic. The presence of minute rhombohedral cavities in the chert, (from the removal by decomposition of small rhombohedral crystals of dolomite,) is a common character by which it may be distinguished from the chert of other formations. This character was first pointed out by Prof. James M. Safford of Tennessee. The concretionary character of most of the chert has also been shown by Prof. F. H. Bradley, to be a distinguishing mark.

Other varieties of limestone, dark blue, argillaceous, &c., occur occasionally in this formation, but the great mass of it is made up of the cherty dolomite above described. In Bibb county it is found, in the localities examined, in two belts. The first belt lies adjacent to the lower part of the Cahaba coal fields, from which it is separated by a fault. The second belt is found some 2 to 4 miles southeast of the first, with strata of the chazy, calciferous sandstone, and Quebec shales intervening.

Useful Materials, &c.

LIMESTONE.—Some of the purer strata have been used in lime burning, but usually the amount of siliceous matter in the dolomite renders it unfit for lime burning as well as for fluxing, an unfortunate circumstance, since the great mass of the limonites of this State, and northward, occurs in this particular formation.

IRON ORES.—In the areas covered by the Quebec or Knox Dolomite, are found the most important banks of limonite or brown iron ore. The general considerations concerning this ore will be found above in the General Outline. I shall here give only the particulars of its occurrence, so far as I have examined it, in Bibb county.

Of the limonites found in the first belt of Dolomite mentioned above, the banks in S. 13, T. 24, R. 10, E., lie nearest to the coal fields. These banks are the property of the Ash-

by Iron Company. As stated before, they are adjacent to the coal measures, and it is extremely difficult to determine exactly where the line of demarcation between the two formations lies. Near the most westerly of these banks, a capping of ferruginous sandstone, and sometimes of a ferruginous conglomerate, exactly similar in appearance to the ferruginous sandstones which are so characteristic of many of the hills of the Drift, is found covering the summit of hills of Carboniferous sandstone. Here, though the hills are mainly the sandstone, there is a superficial covering of pebbles and ferruginous rock, which I am inclined to believe is of much later date. At any rate, on one of the hills which has this capping of a ferruginous sandstone or conglomerate, too siliceous to be of value as an ore of iron, an improvement in the quality of the ore may easily be noticed as one descends the hill, and about half-way down it has been regularly worked. At this point, the surface ore has frequently grains of sand, and in some cases quartz pebbles enclosed in it; but by excavating a few feet, very excellent qualities of limonite, fibrous, ocheous, and compact, (liver ore) are brought to light. This locality, for convenience, may be called No. 1. The old Brighthope bloomary on the Little Cahaba, a few miles distant, was supplied in part with ore from this bank.

The analysis of an *average sample*, selected by myself from this bank, is given below. Mr. J. Blodgett Britton of Philadelphia is the analyst.

Bank No. 1. Limonite. Average Sample.

Sesquioxide of Iron	79.93	=56.10 Metalic Iron
Insoluble siliceous matter, (white sand)	6.04	
Water	10.49	
Sulphur	None.	
Phosphoric Acid	1.01	= 0.45 Phosphorus.
Alumina	1.43	
Lime	.07	
Magnesia	trace.	
Oxide of Manganese	.92	
Undetermined matter, and loss	.11	
Total	100.00	

An analysis of the compact, liver brown variety, from this place, gave me the following composition in 100 parts:

Compact brown iron ore, breaking with smooth conchoidal fracture; color of ore, liver brown; of streak, yellowish brown; quite brittle. Locality, Bank No. 1, Bibb county.

Combined Water	7.41	
Siliceous matter	3.06	
Ferric Oxide	82.84	=57.91 Metallic Iron
Alumina	0.35	
Oxide Manganese	0.95	
Lime	1.02	
Magnesia	0.19	
Phosphoric Acid	0.55	= 0.24 Phosphorus.
Sulphur	0.45	
Loss	3.18	
Total	100.00	

100 Iron contains 0.41 Phosphorus.

The Brighthope Bloomary above referred to was also partly supplied with ore from several other pits close to No. 1.

One of these pits, No. 2, is in the valley at the foot of the hill on which No. 1 is located. The ore here presents the same varieties as that from No. 1, and an *average sample* collected by me, and analyzed by Mr. Britton, shows the following composition in 100 parts:

Bank No. 2. Limonite. Average Sample.

Pure metallic iron	51.96	
Oxygén with the iron	21.14	
Water	12.44	
Insoluble siliceous matter (white sand)	7.84	
Sulphur	None.	
Phosphoric acid	1.35	–0.58 Phosphorus.
Alumina	1.47	
Lime	.11	
Magnesia	.12	
Oxide of manganese	3.36	
Oxide of cobalt	Trace	
Undetermined matter and loss	.21	
Total	100.00	

A large mass of ore, showing some six to eight feet cube above ground, is exposed in place at one of the pits. How much below the ground this mass extends, is not known.

Higher up, on the side of another hill, are other banks from which ore has likewise been abstracted for the bloomary. An *average sample* of the several varieties found here, No. 3, and analyzed by Mr. Britton, gives the following composition in 100 parts:

Bank No. 3. Limonite. Average Sample.

Pure metallic iron	55.05	
Oxygen with the iron	23.58	
Water	12.72	
Insoluble siliceous matter (white sand)	5.61	
Sulphur	None.	
Phosphoric acid	1.30	–.57 Phosphorus.
Alumina	1.36	
Lime	.06	
Magnesia	.10	
Oxide of manganese	.11	
Undetermined matter and loss	.11	
Total	100.00	

The area here over which the ore is exposed, is about three-fourths of a mile square, and the quantity of the ore which these banks may afford in the future, is doubtless very great. The proximity of the banks to seams of workable coal of good quality (about 1½ miles distant in a straight line) must also be noticed.

The rugged nature of the hills, however, will probably make the work of transporting the coal an item of some expense. In Mr. Aldrich's report, the seam known as the *Gholson Vein*, is the nearest to the ore banks. Upon this, an opening was made and worked during the war, in section 10, township 24, range 10, east.

The seam is said to be six to seven feet in thickness, but the opening was filled with water at the time of my visit, so

that I cannot give the thickness except from report. Many tons of the coal have been lying exposed for eleven years, yet the lumps are coherent, and burn well now. It is said to be a non-coking coal.

A short distance from the ore banks just described, in a ridge composed of chert of the Quebec or Knox Dolomite, is a deposit of pipe ore, the extent of which is, as yet, not known, since only the outcroppings of it have been examined. This ore differs materially from those mentioned above. It occurs in stalactitic, botryoidal masses; outer surface brown, giving cherry red powder; mass of the ore reddish brown, affording a dark red powder.

My analysis of this ore shows the following composition in 100 parts:

Pipe Ore, from Ashby Iron Company's Land, Bibb Co., Ala.

Specific gravity	3.78	
Combined water	8.54	
Siliceous matter	2.34	
Ferric oxide	87.49	61.27 Metallic iron.
Alumina	0.27	
Oxide manganese	0.12	
Lime	0.82	
Magnesia	0.33	
Phosphoric acid	Trace.	
Sulphur	0.48	
	100.39	

If found in sufficient quantities this ore will one day be valuable.

In the immediate neighborhood of these banks are several sites on the banks of a small stream, well suited for the erection of a blast furnace. As yet, none of the limestone of the formation holding the ore, has been found fit for use as a flux; but a short distance, half a mile at furthest, from the banks, the belt of chazy limestone, next to be described, holds some beds of very pure limestone. So, also, some of the calcareous

layers of the Quebec Shale, have afforded very good limestones for this purpose.

About one and a half miles south-east of these ore banks, on the eastern edge of the same Dolomite belt, section 19, township 24, range 11, east, is the Owen Bank, also the property of the Ashley Iron Company. The ore here is limonite, and it covers a considerable area. As yet, no explorations of the ore have been made, and the quality of the ore is known only from surface specimens. Most of the pieces are hollow, the cavities being filled usually with yellow ochre, though sometimes with a yellow sand.

Concerning the ores (except the Pipe Ore,) from the above-named localities, and also from Dr. Starr's, (see below), Mr. Britton, who has kindly made the analyses for the survey, writes: "The minerals appear to belong to the same class precisely, and for iron making are unquestionably most valuable. They contain too much phosphorus for "Bessemer" metal, but not so for ordinary foundry iron and commercial bar and rails."

It is usually stated that a pig iron fit for use in making Bessemer steel, must contain not more than 0.10 per cent. of phosphorus in the ore. Now, ores of this degree of purity, as regards phosphorus, are comparatively rare, only three or four localities in Alabama affording them.

It is, therefore, with pleasure that I give the following extract from the pages of a recent number of the Engineering and Mining Journal, written by Prof. R. W. Raymond, U. S. Commissioner of Mining Statistics:

"PHOSPHOROUS STEEL. THE MOTAY PATENTS.

"In May, 1874, letters patent of the United States were granted for the manufacture of Phosphorus Steel, to EDWARD STERN of New York, as assignee of the entire right of C. M. T. DUMOTAY, the inventor, who resides in Paris, France. This new manufacture, which substitutes phosphorus for carbon, as the agent for steelifying iron, will enable steel-makers to substitute the cheap and abundant phosphoric irons of the country for the comparatively rare and costly non-phosphoric

irons, which heretofore have been deemed the only material from which good steel could be made.

Like all patented inventions which advance any important art, a step forward, Mr. STERN's right to his patent for this invention has been contested by other claimants, which is somewhat remarkable, considering the vigorous investigation into the history of the art, by the scientific corps of the Patent Office, which, it is well known, is always made before a patent is granted. But interferences were declared between those who filed the conflicting claims and Mr. DU MOTAY, and in every case, priority of invention has been awarded to him. The last of these cases was decided on the 8th day of the present month (Dec. 1875).

"This important patent having thus successfully run the guantlet of conflicting claimants, its trial, or probationary period, may fairly be considered to have terminated; and it may now be regarded as having entered upon the term of established and conceded validity, which all patents for new and important inventions attain, sooner or later, and those who have taken licenses under it, may rest with confidence upon their title, and safely proceed to construct their plant, which, fortunately, is inexpensive, as compared with that for making the Bessemer or crucible steels, and, therefore, is adapted for use by the small iron works with limited capital, as well as by larger and wealthier establishments."

It is impossible as yet to foresee the extent of the revolution likely to be caused by the introduction of this process, in the manufacture of steel in this country.

Adjoining the Owen tract, mentioned a few paragraphs above, on the land of Mr. Wallace, is also a very considerable show of surface specimens of limonite, of the same character with those last described.

Both these localities are immediately adjacent to the belt of chazy limestone which will afford good material for fluxing.

Of other limonite banks, in this western belt of Dolomite, I may mention the following:

In S. 26, T. 24, R. 10, E., on Mr. Hansberger's land, the limonite is dark bluish, probably from manganese. Many spe-

cimens are botryoidal and covered with a black glaze; others columnar, with radiating fibrous texture. Near this place, the worn pebbles of the drift cover the hill tops, and many fragments of ferruginous sandstone, apparently also belonging to the drift, may be noticed. On the land of Dr. Starr, same section and about half a mile distant, is a large exposure of limonite, fibrous, and compact varieties. The rounded pebbles, ferruginous sandstone, and ferruginous conglomerate (pebbles cemented togother by brown iron ore) of the drift, cover the ground here; and the ferruginous sandstone, like that of the drift, is one extreme of a series of ferruginous rocks, of which pure, fibrous, and compact limonite, with little or no admixture of sand grains, is the other. If the pebbles, conglomerate, ferruginous sandstone, and limonites do not belong to the same period, it is difficult to draw any line between the ferruginous sandstones on the one hand, and the iron ores on the other. It will be remembered that the same transition was noticed above, at one of the banks of the Ashby Iron Company.

An analysis by Mr. Britton of a sample of the ore from Dr. Starr's, shows the following composition in 100 parts:

Limonite from Dr. Starr's. Average Sample.

Pure Metallic Iron	50.07
Oxygen with the Iron	21.08
Water	10.49
Insoluble siliceous matter, (white sand)	14.11
Sulphur	None.
Phosphoric Acid	.80 = .35 Phosphorus.
Alumina	2.65
Lime	.11
Magnesia	.07
Oxide of Manganese	.41
Undetermined matter, and loss	.21
Total	100.00

In S. 34, T. 24, R. 10, E., on Mr. Cottingham's land, is also an occurrence of limonite showing the same varieties as that

at Dr. Starr's. These two banks are probably identical, as they lie adjacent to each other. They are both contiguous to the chazy belt, and hence, in reach of good limestone.

At Mr. Joe Lightsey's, two miles north of Blake's Ferry, on the Cahaba, I am informed, there is another limonite bank. So, also, below Pratt's Ferry, at Mr. Williamson Jones'. These two localities I have not yet visited; but get my information from Col. J. Newton Smith.

Still further south-west there is a good deal of limonite on Mr. Rottenberry's land, but this belongs, I believe, to the sub-carboniferous formation.

Upon the eastern Dolomite belt, are several extensive deposits of iron ore, the best known of which are the Brierfield banks in S. 22, T. 24, R. 11, E., that on Col. J. Newton Smith's land in same section, and that on Mr. J. Allen's land, section 21, same township and range. The quality of the ore from these banks is well known, for the Brierfield furnace has gotten its supplies from them. Of the extent of these deposits I can say very little, having never gone carefully over them; yet the superficial distribution of the ore over nearly two land sections would argue a very considerable quantity.

South-west of this deposit, on Mrs. Carter's land, in S. 31, T. 24, R. 11, E., on Six Mile creek, is another deposit which I have never visited; but derive my information concerning it from Col. Smith.

Any one familiar with the Dolomite belts of Bibb, Shelby, Talladega, Calhoun, and Cherokee counties, will appreciate the difficulty of giving all the localities where limonite is found. Only the more extensive beds can be enumerated, and even of these, there will probably be found in the sequel many omissions. I hope, however, to fill up these omissions at some future time.

All the beds of ordinary limonite described above, occur in clay usually red or yellowish-red, with sometimes white streaks. The ore lies without any apparent regularity, in larger or smaller lumps in the clay. The concretionary origin of the limonite is apparent on most of the fragments. I shall not at this place discuss the mode of origin, or geologi-

cal age of these ores, further than to mention one fact, which has come under my observation: Near Col. Smith's I found a specimen of limonite, a pseudomorph after pyrite, with good crystals, and such specimens are not altogether uncommon.

The Iron Industry in Bibb County.

So far as I know, the manufacture of iron from its ores in Bibb county, prior to 1862, was by means of the Catalan Forge. Of these, may be mentioned, Smith's or Brighthope Bloomary, Camp's, and perhaps one or two others.

In 1862, the Brierfield Blast Furnace was started with C. C. Huckaby, President, and J. Newton Smith, Superintendent; other members of the company were G. Huckaby, Greene S. Wilson, and J. D. Nance. Under this management it continued until 1864, when it was sold to the Confederate States Government. At the close of the war it was confiscated by the United States, and sold by that Government, in 1866, to Frank S. Lyon, of Demopolis. Under the superintendence of Gen. J. Gorgas, the furnace was run by Mr. Lyon for two years, and then leased to T. S. Alviss & Co., under whom it continued until the autumn of 1874, when operations were suspended.

A rolling mill was also worked during the war, and perhaps before that time, at Brierfield; but I have not been able to collect any information concerning it or its management.

Other Minerals.—*1. Barite,* or heavy spar, is of frequent occurrence in the Quebec Dolomite. Maguire's Shoal on the Little Cahaba, and the "Sinks" on Six Mile creek, may be mentioned as localities, but barite is found in veins, in many other places.

2. Calcite and Dolomite are often found crystalized in veins in the rocks of this formation.

3. Quartz.—As was stated above, the dolomite of this formation is characterized by the presence of a very considerable mixture of siliceous matter. Besides the concretionary chert so universally found in it, cavities and fissures are frequently lined with quartz crystals.

Springs.—Throughout the area covered by the Quebec

Dolomite, large, freely-flowing springs are abundant. One of the finest noticed in Bibb county is at the residence of Col. J. Newton Smith. From this spring flows a large body of water, sufficient to make a considerable creek. The so-called "lime sinks," are also characteristic of this formation.

Six Mile creek, in section 26, township 24, range 10, east, flows under a bluff of compact gray and blue limestone or dolomite, and comes to the light again after an underground passage of about a quarter of a mile. Funnel shaped depressions of the ground are also frequent throughout this area, marking the spots where subterranean caverns have been formed, into which the superincumbent earth has fallen. These features are not, of course, confined to the Quebec Dolomite, but they occur in other limestone formations, notably in this State, the sub-carboniferous.

3. Chazy.

The equivalents of this sub-division, are the *Chazy* strata of the New York Reports, (whence the name,) and the "*Maclurea*" *Limestone* of Prof. Safford, of Tennessee.

Localities.—A belt of this limestone lies between the western Dolomite belt and the Calciferous or Knox Sandstone. It is also found at Pratt's Ferry on the Cahaba. That there are many other occurrences of it in Bibb county, other than those specially to be described below, there can be little doubt.

Kinds of Rock.—The most characteristic rock is a blue limestone, often argillaceous, containing locally, immense numbers of the peculiar fossil *Maclurea Magna.* Other strata of the limestone are thin-bedded and flaggy, breaking up easily into regular blocks, with smooth faces. Frequently, beds are encountered which are made up almost exclusively of the fragments of crinoidal stems, with frequent impressions of *orthocerata* sometimes as much as eighteen inches long, and the shells of small brachipods. This limestone, though so full of fossils, will not always yield them to the hammer, and a fresh fracture generally exposes only the crystalline

faces of the limestone. Upon weathered surfaces, however, the fossils are frequently brought into relief.

A compact blue limestone, almost pure, with no traces of fossils, has from its position, been referred to this sub-division, though it may belong to the next higher group. The argillaceous, and flaggy limestones, are very often fetid and bituminous.

A section of the rocks of this period may be seen in passing from Pratt's Ferry, south-east, towards Mr. Cottingham's and beyond. I am unable to give the thickness of the several strata, which are exposed to the extent of about one mile, going across the strike.

Beginning at the ferry, we find the following section in ascending order:

1. Blue compact limestone, with Maclurea magna; the rock is full of the impressions of these shells; but owing to its compactness they cannot be gotten out. According to the angle made between the shell and the weathered surface of the limestone, the shape of the impression varies. When the upper flat surface of the shell and the surface of the limestone coincide, the spiral whorls of the shell are brought out very plainly. When, however, the shell lies at an angle to the weathered surface, oval, crescent shaped, and semi-circular figures are brought out.

2. A crystalline limestone, full of impressions of orthocerata, sometimes eighteen inches long. The mass of the limestone appears to be made up of fragments of crinoidal stems and small brachiopod shells. These show only upon the weathered surfaces of the limestone. A fractured surface of the stone shows only crystalline facets.

3. Grayish shales, or calcareous shales.

4. Smooth-faced, shaly limestone, breaking up easily into regular rhomboidal blocks.

5. Grayish limestone in valley. (Hills covered with drift pebbles.)

6. Smooth, slaty, or shaly limestone nearly vertical, having a very strong bituminous smell. The latter rock is exposed very well in and near the road by Mr. Cottingham's, in

section 34, township 24, range 10, east, whilst the ferry is in section 33, of same township.

The areas underlaid by the shaly, flaggy, block limestone, are covered with a growth of red cedar.

In section 35 or 36, same township, the dark gray bituminous limestone is noticed again, with shaly, smooth-breaking layers. Between this and the exposure of calciferous sandstone on Six Mile creek, (described a few pages above,) the limestone is found only in the depressions, the hill tops and sides being covered with pebbles. Across Six Mile creek, in section 25, township 24, range 10, east, the same flaggy limestone may be traced, and in section 19, township 24, range 11, east, there is a very extensive outcrop of *Maclurea-bearing* beds. Incredible numbers of these fossils are here found, portions of the limestone being almost entirely made up of them. At this locality they are very easily separated from the rock, and specimens six and seven inches in diameter, are not uncommon. The interior of the shells is frequently crystallized calcite. In the limestone of this formation, especially the more massive varieties, a peculiarity in the weathering is noticeable. Where large, solid rounded masses project above the ground, the weathered surfaces are often marked with ridges and furrows radiating from a central elevated point, "as if the fingers had been drawn over it when soft." These ridges show as Prof. Tuomey suggests, that the structure of the rock is not homogenous, and, in the denudation, the harder, more siliceous streaks have been left in relief by the wearing away of the softer portions. I have noticed this peculiar appearance oftener upon the limestone of this period than upon any other, though, of course, similar conditions would cause it to show upon limestone of any age.

Useful Rocks and Minerals.—Many of the limestone layers are pure enough for making lime; some of them are almost pure carbonate of lime.

In two or three of the localities mentioned above, very good flags can be obtained, as the rock splits up very smoothly and evenly.

Many of the outcrops would furnish good building material.

Of minerals, *calcite* is that which has been most frequently noticed in veins, and filling cavities in the chazy limestone.

4. Trenton.

About three miles north of Centerville, in S. 11, T. 23. R. 9, E., a bed of limestone is found, sparry, buff-colored, and made up of fossil remains of brachiopods, orthocerata, &c., and which belongs to this group. The fossils are easily detached, beautifully preserved, and this locality is therefore one of great interest. This bed I have seen at one point only, though there is little reason to doubt that it may be traced some distance towards the north-east.

I am indebted to the kindness of Prof. A. H. Worthen, State Geologist of Illinois, for the determination of the geological position of this limestone.

5. Niagara.

In section 11, mentioned in the preceding paragraph, an occurrence of the fossiliferous red hematite of the Clinton subdivision of the Niagara group was noticed, in close proximity to the Trenton limestone abone described. The fact that the belt of red ore of the Red Mountain group of Prof. Tuomey showed outcroppings in Bibb county, has been known for some years, and this is the most southern point where I have seen it. Of its occurrence further north-east in the county, I know nothing as yet from personal observation. The ore is found on land belonging to Mr. McIlvain of Centerville.

6. Sub-Carboniferous.

This formation in Tennessee has been subdivided into the *Siliceous Group* below, and the *Mountain Limestone* above it. This division is here retained.

Wherever I have seen it in Middle Alabama, this formation is represented principally in the Siliceous group, though several occurrences of shaly limestone, with fossils of the upper group, will be noticed further on, in Shelby county.

In Bibb county, I have as yet to record only rocks of the lower or *Siliceous group*, and these only in one locality.

Five or six miles north-east of Centreville, in S. 6, T. 23, R. 10, E., a ridge of chert may be traced for some distance. The sides of this ridge are covered with angular fragments of chert, full of the impressions of crinoidal buttons, and of brachiopods. On the flanks of the ridge are also seen many masses of limonite, some of which give promise of being good ore, whilst the greater part appears to be too much contaminated with cherty matter to be of much value. This seems to be the case with most of the limonite found in connection with the *Siliceous sub-group*. The chert is sometimes quite hard and compact; but again, it has decomposed into a white powder, filling cavities in the limonite. This siliceous powder is easily distinguished from "chalk," (the name usually given to it,) by its sharp, gritty feel, when rubbed between the fingers.

7. Coal Measures.

Mr. Aldrich's paper will give all the information available concerning the Cahaba fields, so that any details of the occurrence of coal seams in Bibb are unnecessary.

8. Modified Drift.

It has already, in several places above, been intimated that the pebbles, sands, conglomerates, &c., of the Modified Drift are occasionally found covering the hill-tops of some of the Silurian areas described. As we go south and south-east, the Silurian and other formations are soon lost under a deep covering of the Modified Drift, which has not, as yet, been particularly studied.

Shelby County.

General Outline of the Geology of Shelby County.

A general idea of the geological relations of this county can, perhaps, best be given by taking the two coal fields, the Cahaba and the Coosa, as the starting points.

The Cahaba river, above Helena, marks very nearly the eastern limit of the Cahaba coal fields. Below Helena, this limit lies, in general, eastward of the river, as may be seen by consulting a geological map of the State. Crossing Kelly's creek, the line between Shelby and St. Clair, a narrow strip of coal measures, the Coosa coal field is found occupying an area about 6–8 miles wide between the Cahaba and the Coosa rivers. This strip runs, in the northern part of Shelby, nearly south-west, but lower down it turns nearly south, and the sandstones and shales of the formation are found as far south as the line of the S., R. & D. R. R. Between the Cahaba and the Coosa coal fields, as thus described, we find the rocks of the Silurian, Devonian, and Sub-carboniferous formations distributed in the manner given in the details below. It is proper, however, to state here, that the eastern and south-eastern limits of the Cahaba fields are marked by a fault or break in the strata, by which the Calciferous Sandstone and Quebec or Knox Shales are brought up to the level of the coal measures. The *amount* of the displacement thus caused, can be given only after accurate and numerous measurements of the thicknesses of the several strata shall have been made.

This fault has been accurately traced by Mr. Squire from the lower end of the Cahaba fields, as far north-east as Helena; beyond that my own observations have not extended, nor have I the information which can enable me to speak confidently on this point.

East of the Coosa fields, there is another fault by which the Quebec Dolomite is brought up to the level of the coal measures. This, in general, is the geological outline. The detailed examinations have as yet been made only over a small part of the county.

GEOLOGICAL FORMATIONS.

The geological formations, as yet identified in Shelby county, are, beginning with the lowest, the following:

Lower Silurian.	1. Calciferous or Knox Sandstone. 2*a*. Quebec or Knox Shale. 2*b*. Quebec or Knox Dolomite. 3. Chazy, and Trenton.

Devonian......	4.	Black Shale.
Carboniferous.	5.	Sub-carboniferous.
	6.	Coal Measures.

1. Calciferous Sandstone, and 2. Quebec Shale.

The general characters of this rock have already been given, and it is necessary only to give the occurrences in Shelby county, so far as noticed. At Helena, the yellowish and reddish sandstones, with their accompanying shales, are seen in immediate juxtaposition with the sandstone of the coal measures. The best exposure of this proximity of the two formations is seen just east or south-east of the rail road bridge. Above the bridge, at the dam, ledges of this sandstone cross the creek, where they are brought out finely by the weathering away of the interpolated shales. Opposite the office of the Central Iron Works, a spring comes up from beneath a limestone stratum, which probably belongs near the limit between the sandstone and shale.

A marked difference in the dip of the rocks of the coal measures and the Calciferous, may be noticed at this place; for the latter stand almost vertical, with a slight dip, however, towards the south-east, whilst the former dip south-east at an angle of 45 deg. or less.

Going southward from Helena towards Montevallo, the road lies, in general, near the limit of the coal measures. At Mr. Dunnam's, S. 22, T. 20, R. 3, W., the Calciferous Sandstone is seen, nearly vertical, and with a strike almost north and south; and two or three miles south-west, in sections 32 and 33, T. 20, R. 3, W., are the same rocks, showing a strike (perhaps local) of north 20 deg. west. From Helena this place, the variegated sandstones and shales are the prevailing rocks. About six and a half miles north of Montevallo, they are encountered again, and within three miles of that town, the road lies entirely over these rocks. In the immediate vicinity of Montevallo the Knox formation has its best development; but since the Calciferous or Knox Sandstone, and the Quebec or Knox Shale overlying it, are closely associated, and since the two are, in the absence of fossils, scarcely to be sharply sep-

arated, I have thought it best to describe them together. Prof. SAFFORD, in his Geology of Tennessee, makes a three-fold division of his Knox Group, viz:

1. Knox Sandstone.
2. Knox Shale.
3. Knox Dolomite.

The three make in Alabama, as well as in Tennessee, a very well marked natural group –the Sandstone passing gradually into the Shales, by becoming thin bedded and shaly, and at last true shales,—the shales passing up into the Dolomite through the interposition of layers of shaly limestone.

Upon paleontological grounds, the Sandstone has been separated from the Shale; but in the absence of fossils, this separation is very difficult, as there is no well marked line of distinction between them lithologically. It may turn out, if fossils should be discovered, that what I have called the Calciferous Sandstone, is only a part of the Shales, with ledges of sandstone interpolated. Still, since the Calciferous of this report is the exact representative (in color and character of the rock,) of the typical Knox Sandstone, west of Knoxville, I shall refer the variegated thick bedded sandstones, with thin beds of shale, provisionally at least, to this geological horizon. I may here state, however, that I have not noticed fucoidal impressions in any of the sandstones in Shelby, whilst in Talladega, and Calhoun counties, where these rocks occur, these impressions are very characteristic, as they are, also, near Knoxville, Tenn.

In passing from Mr. Aldrich's coal mine, a few miles west of Montevallo, eastward towards the latter town, after leaving the coal measures we go at once into the Calciferous, as is the case at Helena. Crossing a belt of this we come upon the variegated shales of the overlying Quebec formation, and these continue to Montevallo. Near that town, and west of the former residence of Hon. B. B. Lewis, the shales have beds of impure limestone interpolated. These beds have been traced by me about two miles north-east of Montevallo, in section 15, township 22, range 3, west, near the house of Mr. Perry. Here the strata are almost entirely blue lime-

stone, with thin argillaceous bands. The weathering of this rock brings into relief the argillaceous seams, and the limestone appears very distinctly banded. Associated with this banded limestone is a very peculiar conglomerate, composed of small rounded masses of limonite, made up of concentric layers, and held together by a yellowish-white calcareous cement.

The strata of this limestone, from one mile north-east of Montevallo up to this place, strike nearly north-east and dip at high angles south-east. At Mr. Perry's the dip is nearly vertical, and a branch running over the upturned edges of the rock, brings out its peculiar structure very clearly.

This blue limestone, with thin argillaceous seams, lies near the top of the Quebec Shale, and the transition from it into the blue layers in the lower part of the Quebec Dolomite, is very gradual, and may be best noticed in Montevallo, just below (west of) the Female Academy. Down the slope of the little hill, about fifty feet thick of a blue limestone, which is probably the base of the Dolomite, outcrops in successive ledges, forming a very gradual transition to the blue argillaceous limestone which we have just mentioned. Having no fossils by which these rocks can be certainly identified, their exact position is of course, in part a matter of conjecture, still I feel tolerably confident, that the line between the Quebec Shale and the Dolomite, may be found near the point indicated.

Returning now to Mr. Perry's in section 15, and going northward, we cross from the blue banded limestone, into a valley of red, buff colored and yellow shales, which are very characteristic. These shales are found first alternating with thin layers of limestone, which gradually disappear, and there succeeds a belt of the shales, with their peculiar agreeable colors. The valleys formed by these shales are much valued farming areas.

Continuing our course northward, we encounter thin seams of yellowish and reddish sandstones, interbedded with the shales. These sandstones become more numerous as we proceed, and at the mill in section 10, township 22, range 3, west,

they are the prevailing rocks, with subordinate layers, however, of buff, and chocolate colored shales. These, in disintegrating under the influence of the weather, break up into small pointed pieces, which resemble wooden shoe-pegs. How much further north-east this belt oi shales and sandstones continues I have not yet the means of knowing, but I think it probable that it turns northward very soon, if it does not die out altogether, for between the mill in section 10, township 22, range 3, west, and Longview on the South & North Ala. R. R., there is a belt of Dolomite succeeded by the Chazy limestone.

South and south-west of Montevallo, the belt may be traced for several miles, and a very fine exposure of the strata can be seen near the residence of the late Mr. Paul Lewis, where a cut in the branch road running out to the coal mines, lies near the bank of the creek.

On the road from Centreville to Montevallo, about two miles north of where it crosses Mahan's creek, the line between Bibb and Shelby, outcroppings of these shales and sandstones are seen, and these continue to within a mile of Montevallo, where the Dolomite is entered.

3. Quebec or Knox Dolomite.

As this formation is very well exposed in the immediate vicinity of Montevallo, I shall take its occurrence there as a starting point in the description.

In speaking of the Quebec Shale, it was stated above, that the upper blue limestone layers of that formation, pass with gradual transition into the blue limestone observed in the western edge of the town of Montevallo. This limestone, I take to be the lower part of the Dolomite in this place; about fifty feet of it outcrops at the place indicated. Coming into the town, the deep red color of the soil cannot fail to attract attention. This deep red color is characteristic of a belt of land lying between the shales and the first ridge of chert about a mile east of Montevallo; it is due to the iron held by the Dolomite.

Near the bridge over Shoal creek, are bluffs formed by

strata of the Dolomite, and a fine spring issues from beneath the bluff. Some of the Dolomite layers here are banded with thin seams of silicious matter, which become very prominent upon the weathering away of the rock. These projecting lumps and bands of chert, give to the dolomite a very rough and uneven surface.

At this point the strike appears to be nearly north and south, with a dip of five to ten degrees east. This slight dip may be noticed also in the lower strata of the formation, the blue limestone layers, in the western edge of the town, and the passage from these slightly inclined strata, to the nearly vertical beds of the underlying shales, a mile distant or less, is noteworthy.

Going from Montevallo eastward, near the crossing of the creek, another fine spring may be seen issuing from beneath the light gray dolomite of this formation. Continuing eastward, the road crosses near the town a considerable ridge, formed of the chert, so characteristic of the Dolomite, and especially of its upper part. To this ridge succeeds a valley, and then another chert ridge, beyond which we come into the valley underlaid by Chazy limestone. The western edge of this limestone valley is about three miles from Montevallo.

Lying east of the belt of sandstone and shales, already described, and between it and the limestone valley of the succeeding formation, the Dolomite has been observed from Montevallo as far north as Helena, from which place it continues, without doubt, north-eastward towards the Georgia line.

A special enumeration of details concerning its occurrence in the area indicated is not necessary, and I shall confine myself to an account of the

Useful Rocks and Minerals.

First in importance are the iron ores. *Limonite*, or the brown iron ore, is the only one of the iron ores of the formation of any economical value. It would be impossible to enumerate all the localities where it is found. As yet, but few of the ore banks in this part of the county have been worked, there

being only one furnace in the county, though the Brierfield furnace in Bibb, has drawn upon Shelby for a part of its ore.

In the lower edge of the county, soon after crossing the creek which forms the southern boundary, limonite of good quality may be observed everywhere along the road for the distance of a mile or two. Again, in the southern edge of the town of Montevallo, close by the rail road depot, is the bank from which ore was shipped by Mr. Ware to the Bibb furnace. The iron made from it is said to have been of the best quality, and indeed some of the best and toughest iron made in the State has been turned out from the Brierfield furnace. This Montevallo bank, or part of it at least, is the property of Mr. Wells of that town.

Northeast of Montevallo, near Longview, in S. 19, or 20, or 21, T. 21, R. 2, W., is a bank which promises well, but which has not yet been thoroughly explored, unless by private enterprise.

This iron land has, I believe, recently become the property of the Shelby Iron Company.

I give below two analyses by myself, of ores from this place.

No. 1. Radiately fibrous, limonite; outer surface smooth, mamelonated, with reddish color; interior rough, more or less porous and ochreous. Shelby County, six or eight miles northeast of Montevallo.

Specific gravity	4.31	
Combined water	11.19	
Siliceous matter	3.09	
Ferric Oxide	84.10	58.89 Metallic Iron
Alumina	0.27	
Oxide Manganese	trace.	
Lime	1.02	
Magnesia	0.08	
Phosphoric Acid	0.20	— 0.09 Phosphorus.
Sulphur	0.46	
Total	100.00	

100 Iron contain 0.15 Phosphorus.

No. 2. Compact limonite, breaking with smooth conchoidal fracture; moderately brittle; color of ore, light liver-brown; of powder, yellow. Shelby county, six or eight miles north-east of Montevallo.

Specific gravity..................	3.61
Combined water................	11.27
Siliceous matter................	13.49
Ferric Oxide....................	73.44=51.43 Metallic Iron
Alumina........................	1.03
Oxide Manganese..............	0.00
Lime............................	0.38
Magnesia	0.08
Phosphoric Acid..............	0.33= 0.14 Phosphorus.
Sulphur........................	0.28
Total..................	100.30

100 Iron contain 0.27 Phosphorus.

A specimen of limonite from this Dolomite belt, from Shelby county, five miles north-east of Helena, gave me the following composition in 100 parts:

Combined water................	11.98
Siliceous matter................	1.50
Ferric Oxide....................	84.03=58.82 Metallic Iron
Alumina........................	0.20
Oxide Manganese..............	0.20
Lime............................	0.24
Magnesia	trace.
Phosphoric Acid..............	1.22= 0.49 Phosphorus.
Sulphur........................	.03
Total..................	99.40

100 parts Iron contain 0.83 Phosphorus.

West of Siluria on the S. & N. Road, are several occurrences of limonite, of which, however, I have no analyses.

Again, south or south-east of Columbiana, at the Shelby Iron Works, we find one of the most extensive limonite deposits that has been yet explored. The works are in S. 13,

T. 22, R. 1, W., and the ore banks are found within an area of a mile or two about the works.

Of the quality of this ore, analyses given below, and in Prof. Tuomey's report, as well as the well known quality of the iron made from it, are sufficient indications.

Through the kindness and liberality of Mr. Walter Crafts, Supt. of the iron works, I am enabled to give the following analyses of ore made by Prof. C. F. Chandler:

Analysis of ore from the banks of the Shelby Iron Company.

Combined water	9.25	
Siliceous matter	7.06	
Ferric Oxide	78.86	=55.20 Metallic Iron
Alumina	2.37	
Oxide Manganese	1.49	
Lime	0.58	
Magnesia	trace.	
Phosphoric Acid	0.37	= 0.16 Phosphorus.
Sulphur	0.14	
Total	100.12	

100 Iron contain 0.29 Phosphorus.

Roasted Ore from banks of Shelby Iron Co.

Combined water	3.80	
Siliceous matter	11.74	
Ferric Oxide	81.35	=56.19 Metallic Iron.
Alumina	1.59	
Oxide Manganese	0.75	
Lime	0.57	
Magnesia	0.12	
Phosphoric Acid	0.11	= 0.05 Phosphorus.
Sulphur	0.16	
Total	100.09	

100 Iron contain 0.09 Phosphorus.

East of the Coosa coal fields the Dolomite of the Quebec Group is again found, and it makes the country eastward to the Coosa river and beyond, into Talladega county. In many places from Cropwell down to Harpersville, and below to Wilsonville, this dolomite, with its characteristic chert, shows the presence of iron by the deep red color of the soil, and in very many places the limonite is found in quantity sufficient to form ore banks.

Notwithstanding this great superficial distribution of ore, the Shelby Furnace is the only one in the county. There is little doubt that there is ore enough to supply many blast furnaces.

Of other useful minerals found in connection with the dolomite, I may mention that at Kelly's creek a very pure specimen of *pyrolusite* or *black oxide of manganese* has been found. Of the extent of this occurrence, and its relations to the associated rocks, I can say very little.

The chert so characteristic of this formation, has been occasionally, in other States, manufactured into mill-stones, for which some of it is admirably suited, and it might be well if our people would take this fact into consideration.

As in Bibb county, so here, some of the pure limestone strata of the formation are used for lime burning, and in the blast furnaces as a flux.

Iron Industry in Shelby County.

There are two blast furnaces in the county, both the property of the Shelby Iron Company. The works are located about five miles south of Columbiana, with which town there is communication by a branch rail road from the S., R. & D. road.

A blast furnace has been in operation here about thirty years. Furnace No. 1 is 12 feet across the bosh, and 56 feet high. The average yield per day: First blast, 13 tons; second blast, 18 tons; third blast, 14 tons, of 2,268 pounds. The two first blasts were on hot blast Pig Iron, and the last on car wheel Pig Iron.

This furnace blew out December 15, 1874, having made a run of three years, nine months and fifteen days.

Furnace No. 2 went in blast Jan. 6, 1875, and has made an average yield thus far (Feb. 2, 1875,) of 13 tons per day. Furnace is 60 feet high and 14 feet across the bosh.

The blowing cylinder of Engine No. 1 is 66 inches, and 4½ feet stroke; of Engine No. 2, blowing cylinder 84 inches, and 4 feet stroke.

The waste gases are used for heating the boilers.

The ore is limonite, or brown hematite; and fuel, charcoal.

Localities of the ore banks and limestone have already been given above, and need not be repeated here.

Central Iron Works.

R. W. Cobb, President; R. Fell, Jr., Secretary; Postoffice, Helena, Shelby county.

This is the only rolling mill in the State; one at Brierfield, in Bibb county, was destroyed during the war, and has never been rebuilt.

This establishment has four puddling furnaces complete, and one heating furnace; three engines, one of them, which drives the mill, 120 horse power; one muck mill complete; one guide and hook mill; and the shears, squeezer, and punches necessary for the operations of the mill.

The manufacture of the Alabama Loop Cotton Tie is made a specialty.

With the new machinery put in, the production will be about 1,000 tons per annum.

4. Chazy and Trenton Limestone.

Lying east of the Quebec Dolomite, which is found near the eastern border of the Cahaba coal fields, we find a belt of this limestone of variable width.

Part of the rock is impure and shaly, but much of it is nearly pure carbonate of lime, as can be seen from the analyses given below.

Wherever the limestone occurs, the characteristic fossil,

Maclurea magna, can generally be seen upon the weathered surfaces of the rock.

The upper part of the belt seems generally to be occupied by a compact bluish gray limestone in which few if any traces of fossils are to be found. This may belong to the lower part of the Trenton, the Black rivei limestone; but the collections of fossils thus far made are too meagre to render a distinction possible.

In going southward from Helena, after crossing a belt of Dolomite, one comes into a blue limestone area, and the little ridges radiating from a central elevated point can be seen on most of the outcropping masses of the limestone. This limestone here, as in Bibb county, seems to be at the base of the chazy, or perhaps it may belong to the top of the underlying Dolomite. At any rate, a narrow belt of it is found between the Dolomite and the blue limestone with *maclurea*. The road which lies over the lower blue limestone, is one of the worst imaginable, for the rocks all lie near the surface, and above it, and a clear wagon way is impossible without the expenditure of some well directed labor; and, as is well known, in our State such labor is never put upon the public roads. These bald rocky places are covered with a growth of red cedar.

The road from Helena follows this limestone, as far south as Siluria station. Besides the easily recognized *maclurea*, the limestone shows great numbers of other fossils, which are, however, difficult to identify, since they appear only as prominences upon weathered surfaces, and it is impossible to detach them from the rock. No doubt a diligent search would be rewarded by the discovery of some fossiliferous strata from which the shells might be extracted.

At Siluria a wide flat valley is underlaid by this limestone, and the edges of the strata can be seen over the plain, like low walls. The western boundary of the valley here is a ridge of chert of the underlying Quebec Dolomite, and near the foot of it issue bold limestone springs. A fine pond spring was seen upon the land of Dr. Tichenor.

Near the station, and also upon the land of Dr. Tichenor,

a ridge is noticed upon which are some outcrops of an impure argillaceous limestone, which has been burned and tested as to its fitness for a cement rock. The tests made by Mr. Figh, of Montgomery, and Mr. Reynolds, of Prattville, show conclusively that this limonite, properly prepared, will make a first-rate hydraulic cement.

Other localities in Bibb and Talladega counties, where rock occurs suitable for this purpose were visited, but no practical tests have been made of it. There is very little doubt, however, that there is a sufficient quantity of cement rock in the State, but our people seem, as yet, to have given very little attention to this subject.

South of Siluria the Chazy limestone extends in an unbroken area to Longview, in section 19, township 21, range 2, west. Here the Dolomite comes eastward near to the rail road, and the Chazy occupies a belt of about three miles in width, east and west. The eastern limit of it is made by a ridge of sub-carboniferous chert, full of crinoidal buttons.

Below Longview, I have seen very little of this formation, except as far South as the line of the Selma, Rome & Dalton Road, and I cannot give a better idea of its location in this part, than by a section of the strata crossed in going from Montevallo to Calera. The line of this section lies very near the base line of the Huntsville survey.

After leaving the chert ridges, east of Montevallo, which have already been mentioned in connection with the Dolomite, the section passes into a low valley with water-worn outcrops of blue limestone, with the usual "ridgey" surfaces. As well as could be made out, this limestone strikes nearly north and south and dips east. This place is about three miles east of Montevallo, and near Dr. Hale's lime-kiln, which this rock supplies with material. At the crossing of the dirt road and the rail road the limestone is succeeded by a mass of black shales or slates, overlaid by a heavy bed of chert, full of impressions of brachiopod shells and the joined stems of crinoids.

This chert belongs undoubtedly to the Siliceous Group of the Sub-carboniferous. The shales *may be* the so-called

Black Shale of Devonian Age, though I have no means of determining absolutely, this point.

Continuing westward, the ridge of crinoidal chert is succeeded by a belt of black shales, and then by limestone again, probably Chazy; and this alternation of Cherty ridges, with blue limestone, continues as far as Calera. At that place the Chazy limestone prevails. About one mile east of Calera, near Mr. Dare's lime-kiln is a ridge of Crinoidal Chert, with impressions of brachiopod shells, striking nearly north and south, or perhaps a litttle east of north. A blue limestone may be seen at the foot of the western slope of this ridge. From this, the kiln is supplied. I discovered no fossils in the rock, but from its general appearance, and close resemblance to specimens of the Chazy limestone, I have little doubt that it belongs to that horizon.

Near Mr. Thompson's house, just north of Calera, is a quarry in dark blue argillaceous limestone, which is fossiliferous, though I was unable to get a single specimen which could be identified. This limestone is immediately overlaid by a mass of black slates, splitting like roofing slates, but more fragile. About ten feet of these slates are exposed above the limestone. At this particular point the rocks strike nearly east and west, and dip five to ten degrees north. The slates lie under a mass of chert which forms a small ridge. The chert is like that near Dare's kiln, full of impressions of brachiopod shells, and of crinoid stems.

The explanation of the above facts, which seems to me most probable, is that between Montevallo and Calera, the Chazy, and perhaps the Lower Trenton limestone, is bent up into several waves; in the troughs of these waves are the remnants of the Black Shale and Sub-carboniferous Chert, which at one time probably covered also the crests of these folds, but which have been removed by denudation. I put this forth as a conjecture, although my observations of the dip have not been numerous enough to enable me to assert that the strata lie in folds. It may be on the other hand, that a succession of faults has brought about this repetition of the Chazy and overlying beds. I regret that the only

time I have been able to give to this locality has been whilst crossing it hurriedly on my return after the conclusion of the season's field work.

If any of the Upper Trenton, or Cincinnati beds are associated with the above-mentioned Chazy outcrops, they have not yet been identified.

Besides this area, there is a limestone, east of the Shelby Iron Works, which furnishes the flux for the furnace, which from its position between the Dolomite on the west, and Subcarboniferous strata on the east, may possibly belong to this formation. The analyses of different beds of this rock given below, show, when compared with analyses of the Chazy from other localities, great similarity in the composition; though, perhaps, very little significance should be attached to this, since pure limestones may belong to any geological horizon.

Economic Materials, Minerals, &c.

This formation furnishes in this part of the State most of the limestone used in the manufacture of lime.

Calera has long been known for the excellence of the lime manufactured there. At present there are two kilns at that place under the superintendence of Mr. N. B. Dare. The rock is supplied from the formation under consideration.

North of Calera are other kilns supplied from the same source. At Longview, section 19, township 21, range 2, west, is the kiln of Mr. James M. Reynolds.

I give below two analyses by myself, of the limestone used by him.

No. 1. Compact drab-colored limestone, showing occasional crystalline faces; breaking with splintery fracture.

Specific gravity	2.81
Carbonate of lime	99.11
Carbonate of Magnesia	0.75
Iron and Alumnia	0.13
Siliceous matter	0.39
Total	100.38

No. 2. Very fine grained to compact. From same locality.

Specific gravity	2.75
Carbonate of Lime	99.16
Carbonate of Magnesia	0.75
Iron and Alumina	slight trace.
Siliceous matter	0.15
Total	100.06

Both specimens were tested for sulphur and phosphorus, and neither was detected.

The limestone analyzed above, is from the upper part of the belt, and is probably one of the limestones of the lowest Trenton, (Bird's eye or Black river.) Upon this point, however, the evidence of fossils is too scanty, as yet, to enable me to speak with certainty.

All the limestones used for lime-burning at Siluria, Calera, &c., are practically the same in composition as the above. There are of course, slight local variations, but from a number of analyses from various sources, the carbonate of lime is between 95 and 99 per cent.

The following analysis by Prof. C. F. Chandler, has been kindly furnished by Mr. Crafts:

Limestone from Mr. Jones', Section 28, Township 21, Range 2, west, on S. & N. Rail Road near Longview.

Carbonate of Lime	97.52
Carbonate of Magnesia	1.27
Iron and Alumina	0.35
Silica	0.78
Phosphorus	Trace.
Sulphur	0.00
Total	99.92

Near Siluria station are the Rockland Lime-Works of Maj. Wagner. The kiln is in section 35, township 20, range 3,

west. It is built upon Page's patent; the limestone is raised to the top of the kiln by means of an elevator, run by steam power.

The Siluria Lime Works, Messrs. Holt & Co., are in section 2, township 21, range 3, west, about a mile from the station. The limestone is the same as that used by the Rockland Kiln.

A specimen of the limestone from the quarry of the Shelby Iron Company, has been analyzed for the survey by Prof. Stubbs, with the following results:

Carbonate of lime	96.70
Iron and alumina	1.40
Insoluble matter	2.50
	100.60

I append also some analyses by Mr. J. B. Britton of the limestone from the quarry east of the Shelby Iron Works, in section 15, township 22, range 1, east. I am indebted to the liberality of Mr. Crafts, superintendent of the iron works, for the analyses.

Limestone from the Quarry of the Shelby Iron Company.

	No. 1	No. 2.
Carbonate of lime	93.77	98.91
Carbonate of magnesia	2.48	0.58
Iron and alumina	1.01	0.63
Siliceous matter	2.09	1.08
Phosphoric acid	0.00	0.00
Iron pyrites	0.29—0.16 sulphur.	0.10
Water	0.23	0.00
Total	99.87	101.30

No. 3. Seam from same quarry, light colored, granular.

Carbonate of lime	67.55
Carbonate of magnesia	24.91
Iron and alumina	3.58
Siliceous matter	3.46
Sulphur	0.02
Phosphorus	0.03
Water, and loss	0.45
Total	100.00

No. 4. Dark colored, compact seam, from same quarry.

Carbonate of lime	95.40
Carbonate of magnesia	0.94
Iron and alumina	0.68
Insoluble matter	2.25
Sulphur	Trace.
Phosphorus	Trace.
Water, and loss	0.73
Total	100.00

Of other minerals there is not much to record. Just south of Calera, and associated with beds of limestone of this group, is a small bed of limonite exposed in the dry channel of a little branch. The limonite has very intimately mixed with it, in varying proportions, *barite* or *heavy spar*. Some portions of the bed showed almost pure limonite, others limonite and barite in equal proportions, and still others, almost pure barite. Scarcely a hand specimen could be obtained without both minerals.

Barite in veins constantly accompanies the belt of Chazy limestone described above.

4. Black Shale, Devonian.

Of the occurrence in Shelby county of this stratum, the representative, in Alabama, of the Devonian system, I can not feel absolutely certain, yet I have reason to believe that the black shale, which is found immediately underlying the Crinoidal Chert of the Sub-carboniferous formation, between Montevallo and Calera, and beyond that, belongs to this period. I have, as yet, found no fossils in any of it, but in its general characters it agrees with the description of the Black Shale in Tennessee. Characteristic is the occurrence almost universally in it, of spherical or flattened masses of iron pyrites. Scarcely an outcrop of the shale has been seen in which these balls of pyrites have not been found. It is probable that the Shelby Springs, (sulphur,) come from this shale. In other parts of the State, sulphur springs arising from it are common enough.

Near Mr. Thompson's at Calera, there is in the bed of a branch a black bituminous shale which will burn, and it is found underlying a ridge of Crinoidal Chert, of Sub-carboniferous age. From Mr. Dare and Mr. Thompson, I learn that the same shale is found in the vicinity of Calera, in a similar position at many other points.

The section of strata between Montevallo and Calera, given a few pages above, may also give some information upon this point.

5. Sub-Carboniferous.

In speaking of the Chazy limestone, most of the occurrences of this formation, in Shelby county, within the area examined, have already been given.

The formation is represented usually by its lowest member, the *Siliceous*, and the principal rock is a porous chert filled with the impressions of shells, and crinoids. The dissolving away of the calcareous parts of the shells, &c., gives to this chert its porous character.

The chert usually forms ridges which have their normal position on the eastern limit of the areas of Chazy limestone. Such is the case from Siluria to Calera, where I have exam-

ined it, and it is probable that in a similar relation to the Chazy it will be found further northward.

Characteristic ridges of this chert are, the one just mentioned; that lying east of Mr. Dare's lime-kiln; one near Mr. Thompson's house at Calera; and finally the succession of low ridges, dividing strips of Chazy limestone between Calera and Montevallo.

East of the Shelby Iron Works there is another representative of the formation, in a shaly blue limestone which weathers into a dark brownish shale. This limestone is full of fossils, some of which are in a beautiful state of preservation. Chief amongst these are the delicate, lace-like traces of bryozoans. A species of Productus is common, as are also the fragments of the stems of crinoids. One crinoid head found, proves to be a pentremite. Cyathophylloid corals also are not rare.

The locality is in S. 11, T. 24, R. 15, east, near the house of Mr. John T. Wilson.

Specimens from this locality were submitted to Prof. A. H. Worthen, State Geologist of Illinois, who considers them as belonging to the equivalent of the Chester Limestone of the Illinois Geological Reports. This would bring them into the Mountain Limestone Group, of our subdivision, and the occurrence of strata both of the Siliceous and Mountain Limestone Groups of the Sub-carboniferous thus far south in Shelby, is as interesting as it was unexpcted.

Of useful materials in this formation, might, perhaps, be mentioned the chert, which often approaches in character buhr-stone.

On very few of the cherty ridges enumerated above are accumulations of iron ore—the brown ore wanting. So far as my observation goes, however, it contains too much silica, though frequently specimens of very fine limonite occur.

6. Coal Measures.

Mr. Aldrich's paper will give all the information within our reach, concerning the Cahaba coal fields. Of the Coosa fields no detailed examination has, as yet, been made, but notice of

them and also of the Warrior fields will be found in the paper referred to.

Between the ridge of sub-carboniferous chert at Dare's Lime Kiln near Calera, and the belt of Knox Dolomite east of Columbiana, there is a great series of sandstones and shales, with one or two strips of limestone. I have not as yet been able to determine with certainty the age of these rocks, having found no fossils in them; but I have little doubt that the sandstones and shales belong to the coal measures of the Coosa field which extend southward as far as the line of the S. R. & D. rail road, and probably to the Metamorphic area below that.

In this opinion I am strengthened by the fact that strips of sub-carboniferous chert are found in several alternations with Chazy or Black River Limestone, between Montevallo and Calera; and north of Calera, the sub-carboniferous cherty ridges have been traced as far as Siluria Station. East of that point, some two or three miles, I am informed by Dr. I. T. Tichenor, President of the Agricultural and Mechanical College, that a bed of coal has been found. This could scarcely belong to the Cahaba fields, and it is Dr. Tichenor's opinion, also, that it belongs to the Coosa fields. Within the area of sandstones and shales which I have mentioned, are found one or two, and perhaps more, strips of limestone, which are believed by Prof. A. H. Worthen to be of the age of the Chester Limestone of southern Illinois (sub-carboniferous), although no fossils were found in it, sufficiently well exposed to allow of an absolute determination. With this same limestone, or near it, is also found a moderately thick stratum of black carbonaceous shale, with lenticular concretions of iron pyrites, which *may be* the Black Shale of Devonian Age. In the vicinity of Shelby Springs, which is in the midst of this sandstone and shale region, are found also beds of limestone, and the sulphur water may be derived from the shale. These, however, are mere conjectures, since without recognizable

fossils the determinations of the ages of the rocks can not well be made with certainty. South-east of Columbiana, about four or five miles from the Shelby Iron Works, is another belt of shaly limestones with easily recognizable fossils, belonging to the sub-carboniferous group (Chester Limestone), according to Prof. Worthen's determination; (see, also, above.)

I have thus given the reasons for the belief that the shales and sandstones, which make up so large a part of the central region of Shelby county, are those of the coal measures of the Coosa fields.

It may be noticed also, that further north-east, near the Coosa Valley road, just south of Kelly's creek, and also below Harpersville, the same sandstones and shales are observed, and on the way from Harpersville to Columbiana the country is a barren piney woods from near the former town to the valley of Four Mile creek, which is Knox Dolomite. Siliceous sandstones, with occasional faces drusy with quartz crystals, and yellowish argillaceous shales, make up this barren country.

At Morgan's Mill a good exposure of the sandstones is found, and upon fragments of these rocks just below the dam, I found a black carbonaceous shaly material filling in fissures in the sandstone, and covering some of the faces of it, a thickness of half an inch and more. This shaly substance looks very much like coal, but has only a small percentage of carbon. It burns white before the blow-pipe, but does not decrease materially in bulk.

Out towards the north-west from Harpersville and Kelly's creek, is the rough, rugged country which is laid down on Prof. Tuomey's map as the southern portion of the Coosa coal fields. I can not, therefore, resist the conclusion, from my observations, that these measures extend still further south to the limit given above. I know, however, of no *coal* found further south than the locality mentioned near Siluria.

Near Columbiana, north-east, is a prominent ridge called, locally, the "Mountain;" but as my observations about Co-

lumbia have been too limited to enable me to give with certainty the geological equivalents of the strata, I shall only give here a section of the rocks composing the Mountain, reserving a further description of this whole region to some future time.

The Mountain has the shape of a horse-shoe, with the two free ends pointing north-east. Around the north-western arm of the horse-shoe flows Beeswax creek, which cuts the south-eastern arm in two at Leeper's Mill, S. 21, T. 21, R. 1, east.

In going over the Mountain from Columbiana, we cross a series of gray and buff shales with limestone at the foot of the ridge; higher up the Mountain, shaly sandstones passing into a fine grained conglomerate, with quartz grains of the size of a wheat kernel to that of a pea. (This conglomerate is exactly like specimens obtained from the Potsdam sandstone ridges in Talladega county.) The conglomerate forms the crest of the Mountain, and is succeeded on the other slope of the hill by highly ferruginous shaly sandstones, several strata of which become a tolerably fair ore of iron, as may be seen from the appended analysis. This ore is a *red hematite*, compact, and laminated, breaking into rhomboidal fragments, by reason of a series of joints. Minute clear crystals of quartz are imbedded in the ore, which are of vitreous lustre on the fresh fracture, but become white and opaque after exposure.

The ore does not seem to be confined to any one single stratum, but the shaly rock occurring with it has more or less of iron in its composition, so that in places it becomes an ore.

Succeeding these rocks, is a second bed of conglomerate similar to the first, and after it shales and shaly sandstones to the bottom of the hill. Where crossed, the strata have the strike of the ridge, N. 10 deg. W. and dip N. 80 deg. E.

On the south-east arm of the horse-shoe the Mountain is cut by Beeswax creek, and Leeper's Mill is just below one of the ledges of conglomerate. The same shaly ferruginous sandstones passing into an ore of iron, are here observed also. The strike is east north-east, and dip at an angle of 75 deg. or

more to the north north-west. Here also limestone is seen dipping under the sandstones at the foot of the ridge, whether conformably, or not, I am unable to say.

The geological equivalents of these rocks have not yet been satisfactorily made out, and I shall leave that part of the subject to a future occasion, remarking only that the conglomerate, to which the ridge owes its height and prominence, is precisely like some specimens from the Potsdam sandstone further north.

Through the courtesy of Mr. Walter Crafts of the Shelby Iron Works, I am enabled to present the following analyses:

Limestone from Quarry on S., R. & D. R. R., near Columbiana, by Dr. C. F. Chandler.

Carbonate of Lime	89.03
Carbonate of Magnesia	3.91
Iron and Alumina	1.08
Iron Pyrites	0.26—0.136 Sulphur.
Phosphoric Acid	0.00
Silica	4.88
Water	0.64
Total	99.80

This is the limestone mentioned as dipping under the sandstones of the Mountain. Analyses of the same rock from Beeswax creek are found in Prof. Tuomey's Report.

Two analyses of the red hematite ore from the mountain, No. 1, by Mr. J. B. Britton, and No. 2, by Dr. Chandler, are also given:

No. 1.

Metallic iron	44.61
Silica, &c	29.06
Sulphur	0.00
Phosphorus	0.30
Alumina	3.66
Manganese	1.00

100 parts Iron contain 0.67 Phosphorus.

No. 2.

Ferric oxide	70.09–49.08 Metallic iron.
Silica	23.45
Sulphur	0.11
Phosphoric acid	0.77–0.34 Phosphorus.
Alumina, lime, magnesia, &c.	5.58
Total	100.00

100 parts Iron contain 0.69 Phosphorus.

The analyses are made from ores from two different localities, and the close agreement in composition is very noticeable.

Near Calera, on the banks of Buxahatchee creek, are found bluffs of black slate which were noticed by Prof. Tuomey years ago. Other localities in the vicinity of Buxahatchee show similar outcrops of these slates, which have been examined in several places as to their fitness for roofing slates. As yet, I know of no quarrying done in them, and I am unable to give their geological position, having spent only a short time in the neighborhood.

Between Shelby Springs and Columbiana, slates are well exposed in Camp Branch and on Waxahatchee, and the examination of these localities as well as those on Buxahatchee, will doubtless be of much interest.

TALLADEGA COUNTY.

Topography.

Talladega county lies between the high range of hills called the Blue Mountain, Rebecca Mountain, &c., on the east, and the Coosa river on the west. The water courses, with the exception of Talladega creek, have their sources on the western flank of the prominent quartzite ridge called Blue Mountain, and flow westward into the Coosa. Talladega creek, on the other hand, takes its rise in the Metamorphic hills, cuts its way through the highest of these, and through the slates and conglomerates of the Acadian group, and flows thence south-westward into the river.

The principal range of hills in the county is the Blue Mountain on the eastern border. Next, in point of height, are the hills of Potsdam sandstone. West of the S., R. & D. Rail Road, from Alpine station to Choccolocco creek, may be seen one of the most prominent of these ranges. At Alpine the height of one of the summits is 2,000 feet above the rail road level, or 2,495 feet above the sea level. North-east of Talladega the peak called Mt. Parnassus is one of the most prominent of these in that vicinity.

In the south-western corner of the county, is a broken country called the Kahatchee Hills, which are, in part at least, Potsdam sandstone. A prominent peak amongst these lies immediately behind the residence of Mr. Albert Crumpler. It is 800 feet above the rail road level at Childersburg.

Of secondary importance are the numerous cherty ridges of the Knox Dolomite. Some of these are isolated knobs, and have the name mountain attached to them. One of these, west of Alpine, is Calhoun Mountain, about 375 feet above the level of the Coosa at that point.

General Geological Outline.

The geological formations found in Talladega county, are—

Lower Silurian.	1. Acadian—Conglomerates and slates, semi-metamorphic.
	2. Potsdam—Sandstone.
	3. Calciferous—Sandstone, or Knox-Sandstone.
	4. Quebec, (*a*) Shale, or Knox Shale.
	(*b*) Dolomite, or Knox Dolomite.
Devonian.	5. Black Shale.

By far the greater part of the county is covered by the strata of the Quebec Dolomite, which stretches, with the few interruptions to be described below, from the Coosa river eastward to the semi-metamorphic slates and conglomerates of the Acadian Group.

Near the centre of this area, or about half way between the Coosa and the Acadian Hills, rises a range of hills, or more properly mountains, of Potsdam Sandstone, which has, along its eastern flank, a fringe of varying width of Quebec Shales chiefly, though the Sandstone is not wanting in places.

In the southwest, the Kahatchee Hills, also Potsdam Sandstone, make a very rugged country. Patches of the Dolomite, and also of the Quebec Shales, are caught in amongst these hills, and in some instances, half metamorphosed.

Lastly, the Black Shale is found on the western flanks of the Potsdam Sandstone of the Kahatchee Hills in one or two localities, in the extreme southern and western portions of the county.

Details.

1. Acadian Slates and Conglomerate.

The western border of the Metamorphic rocks in Alabama, is formed by a belt of slates and conglomerates, semi-metamorphic in aspect, and varying width, but perhaps of an average width of six miles. These rocks which, in every respect seem to be the exact equivalents of Prof. Safford's Ocoee Slates and Conglomerates, are referred like them to the Acadian Epoch.

In my report for 1874, these rocks have been described somewhat at length, and I shall give here only a detailed section of them along Talladega creek, from Dr. Taylor's mill, in section 13, township 19, range 5, east, as far up the creek as the Upper Falls, in or near section 27, township 19, range 6, east, a direct distance *across the strike* of about five or six miles, although following the meanderings of the creek, the distance is much greater.

At Dr. Taylor's mill, the creek flows through a narrow gorge over one hundred feet deep, cut into greenish talcoid or hydro-mica slates, emerging into the Silurian Valley at that place. The eastern part of the valley is occupied by a narrow belt of crystalline marble, blue and white, which, from its position and the associated minerals, I have little hesitation in pronouncing metamorphosed Knox Dolomite, (see below.) About a mile up the creek from the mill, the more compact strata of talcoid slates form a barrier, over which the waters of the creek fall in several beautiful cascades, ten feet and more in height. The long continued action of the waters has worn the rock into numerous pot-holes, in which flourish many varieties of water plants, and numerous fresh water gasteropods. As far as up as Riddle's mill, in section 16, township 19, range 6, east, the same slates prevail, and the creek flowing in general *across the strike*, is often deflected from its normal northwest course, and flows along the line of strike. Wherever the creek has been thus turned aside, the slates are more compact and tougher, and present high bluffs, upon which, in the crevices of the rock, a scanty growth of *red cedar* is always found. In other places, where the creek flows along the strike, the rocks appear to be much softer, though showing, in general, the same characteristics as the harder portions. In these places, also the creek has always a narrow bottom on each side, and the precipitous bluffs are wanting. In the south-west quarter of south-west quarter of section 17, township 19, range 6, east, is the crushing mill of Senator A. Cunningham, and the gold mine is in section 20, adjoining. The auriferous quartz vein, of varying thickness, lies in a partially decomposed slate of

the nature of those spoken of above. (See also below.) The width of the belt of tolerably uniform slates, (greenish, talcoid or hydro-mica slates,) between Taylor's and Riddle's mills, is about four miles.

The numerous shoals and falls formed where the creek cuts through the harder strata of the slates, furnish water power in abundance. It has been utilized at three or four points only as yet, viz., Taylor's, Cunningham's, and Riddle's Mills, and at the site of the old Maria Catalan Forge, in S. 17, T. 19, R. 6, east. This forge, like others of its kind, has been abandoned since the introduction of blast furnaces.

Above Riddle's Mill, the smooth, greenish slates become more and more siliceous, and pass soon into a conglomerate, which, with many alternations with softer yellowish, buff colored, and greenish talcoid slates, makes up the country as far as the upper falls of the creek.

The conglomerate, which is sometimes a slaty, arenaceous rock, but oftener quite massive, is made up of the lumps or pebbles of *opalescent* quartz, and opaque white fellspar, held in a matrix of greenish talcoid matter. Where the greenish matrix prevails, the weathered masses of the conglomerate show a beautiful dark bluish green color. Other weathered masses of this conglomerate are lighter and more yellowish in color.

Characteristic are the bluish, milky white *opalescent* quartz pebbles or grains.

All the bluffs and shoals of the creek above Riddle's Mill, to the Upper Falls, are caused by these heavy beds of conglomerate. Frequently large blocks of the rock have been loosened from their places above by weathering, and have rolled down the steep hill-sides into the edge of the water, and, in some instances, far into the bed of the creek, causing the waters to make a detour. It is upon these immense blocks of conglomerate, (often larger than the ordinary log-cabins of the country,) that the pleasing bluish green color is best seen. Upon a fresh fracture it is not so evident. In several places the creek flows through narrow gorges in the conglomerate, where the rocky banks of the stream rise abruptly, almost

precipitously, at least two hundred feet above the water level.

It needs scarcely to be mentioned that the shoals thus formed afford an almost unlimited water power.

The old Eagle Forge and the Rob Roy Forge were located upon this creek, the former in the south-east part and the latter in the northern part of S. 21, T. 19, R. 6, E.

The rugged nature of the hills which lie between this magnificent water power and the outside world, will stand in the way of its utilization for some time to come. It should be noted, however, that the construction of a roadway along the banks of the creek, whilst necessitating the expenditure of a large amount of money and labor, would undoubtedly be a long stride towards bringing to light the mineral treasures of the Metamorphic regions beyond; for it would open an easy highway far up in the heart of this region.

That this is feasible, the excellent roads lately constructed along the Ocoee, and similar streams in Tennessee, are a sufficient proof.

Above the site of the Eagle Forge, a belt of soft green talcoid or hydro-mica slates is found, similar to those below Riddle's Mill.

The Upper Falls are formed by a heavy-bedded quartzite which forms the crest of the highest ridges in this part of the Metamorphic region. The Blue Mountain and Rebecca Mountain are formed in great part by it.

The quartzite is principally, at this place at least, a dark bluish almost massive rock, with some mica, and perhaps feldspar. Subordinated, are lighter colored beds, and also a very coarse conglomerate, frequently ferruginous. Towards the eastern flank of the ridge, I have always found a thin-bedded, fine grained siliceous slate, which breaks up into small pieces resembling chips of wood. The siliceous slate varies in color from a dark slaty gray, to almost white.

The "Great Falls" are located upon the maps at this place, where the creek cuts through the quartzite. They are, however, beautiful shoals, but hardly true falls, as the highest of them are not more than three or four feet. The lowest falls,

just above Taylor's Mill, are much more deserving of the name—falls.

Since the writing of my last report, I have reason to believe that the quartzite just spoken of is a metamorphosed Potsdam Sandstone. This point, however, will probably soon find its solution at the hands of Prof. Frank H. Bradley, to whom belongs the credit of having done more than any other man towards settling the disputed question of the age of the Metamorphic rocks of the Southern Apalachians.

As one point of resemblance between the quartzite and the non-metamorphosed Potsdam Sandstone, may be mentioned the abundance of fine chalybeate springs, found in so many localities upon the flanks of each. (See Report of 1874, pp. 42 and 65, and also below, under Potsdam Sandstone.)

Along the banks of Talladega creek, above Riddle's Mill, the bluffs and shoals, with few exceptions, are formed of conglomerate; it is not to be inferred, however, that softer slates are entirely wanting. Along the road from Ashland to Talladega, a few miles south of the line of the creek, the slates are seen to be almost, if not quite, as abundant as the beds of conglomerate.

Below Riddle's Mill I believe the conglomerate plays a very subordinate part; heavy beds of greenish, soapy-feeling, smooth slates prevailing almost exclusively.

Lastly, I may state that the rocks just considered have, almost without exception, a strike of north-east and south-west, and a dip of 45 deg. or so, towards the south-east. I have never yet noticed any occurrence of the reverse dip (to north-west) in this belt of slates, &c., either at this place, or elsewhere, where I have crossed it.

Of Useful Minerals, in this formation in Talladega county, I have only to record *gold*, which has been profitably worked at the Riddle Gold Mine, (now the property of Senator Cunningham.) Much of the quartz here mined shows the gold plainly to the eye, and the numerous assays of samples from various depths, as well as the testimony of those who have worked the mine, show that the mining can be carried on with profit.

It is plain, however, that with the rude machinery used much of the gold is lost in working up.

Gold has been mined also north-east and south-west of this place, in the same belt, but with no other appliances than the pick and pan.

2. Potsdam Sandstone.

Of the sandstone of this age in Talladega county, there are two distinct occurrences; the one in the northern, and the other in the southern part of the county. The former, being more simple in its details, will be first described.

Two or three miles north of Alpine Station, on the S., R. & D. R. R., a range of mountains extending from near Choccolocco creek above Talladega, ends with three high and prominent peaks. From these peaks a lower range may be seen turning southward, but soon dying out. This range is the first of the Potsdam Sandstone indicated above. Whilst the range as a whole is a very distinct feature of the landscape, it is found to consist of a succession of higher points, with low places or gaps between.

Mt. Parnassus, north of Talladega, is one of the well known land marks of this range, and the three high points near Alpine are others. The range is not continuous, but made up of a succession of short ranges, not however, following each other in the same straight line; but as one dies out, another sets in *en echelon*, a little to the east or west of it, and thus the chain is prolonged. Through the gaps thus formed pass the various roads leading from Talladega to the ferries on the Coosa. The highest of the three points at Alpine, measures by the aneroid barometer 1,000 feet above the level of the rail road at the station, or 1,495 feet above tide water.

The height of Mt. Parnassus, I have not measured, but it cannot be much less than that of the Alpine peak.

The chains of Potsdam Sandstone often end abruptly, and after several miles of level country, begins another chain quite as abruptly as the other ended. The geological position of the sandstone is quite simple in this county. It is

bounded on the west by the strata of the Quebec Dolomite, being brought up to that level by the faultings so common in the region of the Appalachians. The eastern flanks of the mountains and a strip of varying width at their feet, are usually formed by the shales of the Quebec formation, which are in turn succeeded by the Dolomite, which then covers the country to the next fault by which the Acadian slates are brought up to the day.

It is probable that the Calciferous Sandstone intervenes in most places between the Potsdam Sandstone, and Quebec Shales, and, in truth, in those gaps left where one chain ends and the other begins, it is often found.

The rocks are sandstones chiefly, with some fine grained conglomerate, with pebbles not larger usually than grains of wheat. Characteristic markings in most places, are the sandy rods caused by the boring of a marine worm *Scolithus linearis*, into the yet soft sands of that ancient sea-beach, and the subsequent filling in with sand of these worm burrows, so that when the loose material of the old sea shore was compacted into a rock, these traces were preserved. These scolithus rods are extremely abundant in some localities of the Potsdam Sandstone, whilst others appear to lack them altogether. I have not observed any other fossils in these rocks in Alabama.

In making the ascent of the mountain at Alpine, at its base is seen an outcrop of shaly, cherty limestone,* belonging in all probability to the Dolomite of a later formation, which has been brought up by faulting to a level with this. At one point half way up the mountain there is exposed a bluff of sandstone, striking about five degrees east of north, and dipping about eighty-five degrees to the south of east. One layer here exposed is a black ore of iron, with somewhat resinous lustre, fragile, and having somewhat the appearance of coal.

A partial analysis of this, by Mr. Britton, shows the following composition:

*This rock affords some beautiful specimens of oolitic limestone.

Metallic iron	56.74
Insoluble siliceous matter (white sand).	0.76
Sulphur	None.
Phosphorus	1.52
Manganese	Trace.

An exceptionally large amount of phosphorus, equivalent to about 3.00 phosphoric acid, is the noticeable feature of this curious ore.

A thin coating of limonite is seen in many places on the exposed faces of the rock, and, indeed, here as well as elsewhere, the Potsdam Sandstone seems to hold a considerable quantity of iron, either as pyrite or as its decomposition product, limonite.

Near the summit, the heavy ledges of sandstone which form the crest of the mountain begin. On account of the thickness of these beds, the rock appears almost massive at times, but where the bedding could be made out the strata show a dip of between 85 degrees and 90 degrees towards the south-east. Upon the summit of this and other mountains of this formation, are huge piles of rocks, the broken remnants of once continuous ledges. Upon these a scanty growth of oak, usually gnarled and often stunted, prevails; whilst under foot, the crevices between the rocks afford favorite retreats for the rattle-snake and black-adder. Other forms of life are rarely seen upon these bleak hill tops, except a clumsy black grasshopper, spotted with red, which is a constant denizen of the most barren soils.

From the bold and abrupt manner in which these hills rise from the surrounding plains, fine views are nearly always to be had from their summits, so that the ascent of them more than repays the geologist for the fatigue endured, in giving him, so to speak, his geological bearings. In this case, to the westward across the Coosa were the blue outlines of the hills of the St. Clair (Coosa) coal fields. North-eastward stretched the chain of Potsdam Sandstone, from the point where we stood, far beyond Talladega. Eastward were the mountains of the Metamorphic with the subordinated hills of Acadian slates and conglomerates on this side; between, lay

the valleys and cherty ridges of the Quebec Dolomite. Southward, the broken country known as the Kahatchee Hills, showed some system in its structure when viewed from this elevated point.

The large amount of iron in the sandstone of this formation is shown by the chalybeate springs which have their sources in the mountains. A very fine spring of this kind is the Chocco Spring of Mr. Jarrett Thompson, some three or four miles north of Talladega. Near this spring, also, a considerable show of limonite is found, which seems to belong to the sandstone, though it may belong to the overlying Dolomite.

North-east of Talladega, on Mr. Bowie's place, is another strong chalybeate spring at the foot of the mountain.

3. Calciferous or Knox Sandstone.

On the eastern flank of the range of Potsdam Sandstone, which was the subject of the preceding section, it is probable that a fringe of Calciferous Sandstone will be found, though as yet I have not certainly identified it.

Some three or four miles west of that range, however, there is a very fine exposure of it at the Jackson Shoals on Choccolocco creek, in S. 22, T. 17, R. 5, E., about eight miles due north of Talladega. At this point a sharp comby ridge of Calciferous Sandstone, striking north-east and south-west, is cut through by the creek, forming beautiful shoals for about half a mile. The section of Calciferous strata here, beginning at the foot of the shoals and going up stream, stratigraphically also, from below upwards, is—

1. Alternations of sandstones and shales, 800 to 900 feet thick. The colors of these rocks are exceedingly characteristic, buff, gray, and chestnut brown, the latter color prevailing. The shales graduate into shaly argillaceous sandstones, and these into hard compact sandstones, which often show a large amount of green glauconite grains. By the weathering of these portions of the rock, the outer surface has a very dif-

ferent color from the inner, being a yellowish brown, from the oxidation of the glauconite, whilst the unaltered interior of the rock is a decided green.

The softer shales between the harder sandstone ledges, wearing away more rapidly, have left these projecting in a series of dam-like ridges, striking across the creek, and over these the water tumbles in small cascades.

2. Light gray dolomite, usually quite cherty, though some parts of it are pure enough to furnish tolerably good lime—60 feet or more.

3. Sandstones, with smooth shining bedding planes, which often show ripple marks, and fucoid impressions. These rocks are sometimes almost shales, sometimes tolerably thick bedded. The color is generally a reddish or chestnut brown, with some gray layers. Thickness about 60 feet. This forms the upper sandstone barrier, or the beginning of the shoals, and the more rapid wearing away of the shaly strata, brings into prominence the harder sandstone, as in 1.

4. Almost black limestone, which passes below into the sandstone No. 3. About 20 feet of this exposed.

These rocks all dip south-east at an angle of 40 degrees or more, and the entire thickness of the strata exposed, I have estimated at between 900 and 1000 feet, which is probably not far from the truth.

From the Jackson Shoals this Calciferous ridge stretches in a direction a little east of north, across Blue Eye creek, towards Cane creek in Calhoun county, about the center of T. 15, R. 6, E.

I have not personally traced this ridge, and give the above on the authority of Senator A. Cunningham.

The fall of water at the Jackson Shoals is over 25 feet, and as the creek is a bold full stream, the amount of water power can easily be imagined. There would be very little difficulty in constructing the dams, as the sandstone ledges form themselves tolerably good dams already.

4 (*a*). Quebec or Knox Shales.

The Potsdam Sandstone range west of Talladega is fringed

on its eastern foot by a varying width of these shales. At the town of Talladega the shales are found as far eastward from the mountain as the rail road depot. The town is, therefore, upon the line of junction between the Shale and the overlying Dolomite; the strata of both formations being found within the city limits.

In going south-west from Talladega to Alpine, along the eastern side of the Potsdam Mountain, our road lies, in great part, over these shales. Their general character is the same wherever I have seen them in Alabama and Tennessee, yelow, buff, gray, greenish, and reddish-brown colors prevailing. On the Stone's Ferry road, beyond Mr. Turner's, the shales show thin-bedded sandstones, with ripple marks, interpolated between their layers, and at Mr. Dick Hillsman's these shales *seem* to be underlaid by a shaly or flaggy limestone, almost black, and very fine grained and compact. It is, at this place, characterized by the occurrence in it, or between its layers, of concretions of dark hornstone. These concretions look like rounded water-worn pebbles or boulders, and their true nature is revealed only when broken open.

Beyond this comes the range of Potsdam Sandstone. It is quite probable that some of the strata which I have just described belong to the underlying calciferous formation, though at this point a line of demarcation between them is hard to draw.

At Alpine, or rather at Plantersville, the shales are found skirting around the southern end of the Potsdam chain, which dies out abruptly at this place.

Of *useful material* in this horizon, I have none to enumerate.

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4 (b). Quebec or Knox Dolomite.

Distribution and Topography.

The greater part of the superficial area of Talladega county is made by the rocks of this formation.

For convenience, its occurrence in the Kahatchee Hills will be considered separately.

The Potsdam range, stretching from the Choccolocco southwestward to Plantersville or Alpine, divides the Dolomite in the northern part of the county into two areas. By referring to the details of Shelby county, it will be found recorded that a strip of Knox Dolomite lies between the Coosa coal fields and the river. This continues across the river and makes the country as far eastward as the Potsdam chain, with the exception only, so far as noticed, of a ridge of Calciferous and Knox Shale which crosses Choccolocco at the Jackson Shoals. Eastward of the Potsdam chain, I have noticed no other rocks than those of this period, until the hills of Acadian slates are reached; a distance of four to six miles. In general, that part of the county west of the Potsdam chain is somewhat broken, and extremely barren, with the exception of a few favored spots. The reason for this lies in the fact that the chert of this formation covers very considerable areas there, and where that is the case, pine barrens are found. I need only to refer to the country traversed by the road from Talladega to Collins' Ferry; also along the road between Alpine and Glover's Ferry.

A large tract of country between Alpine on the north, the Kahatchee Hills on the south, and the Acadian Hills on the east, is somewhat rolling, but good farming land, and many valuable farms are found there. The strip five or six miles wide between the Potsdam chain and the Acadian Hills is the most attractive, perhaps, of any part of the county. Most of this has a deep red fertile soil, and many fine plantations and elegant villas are seen from the valley road.

GEOLOGICAL DETAILS.

On the road from Gadsden to Talladega, where it enters Talladega county from Calhoun, barren hills covered with chert prevail, as far as section 16, township 16, range 6, east, near Mr. Dill's, where a valley road begins and is followed to Eastaboga, and south-westward to the Jackson Shoals on Choccolocco creek. This valley, or succession of valleys, is characterized by a deep red colored, and apparently fertile soil, in which is found much limonite. At Mr. Dill's a fine

spring is the source of Blue Eye creek, which flows thence west-ward into the river.

Turning west-ward from Eastaboga we come soon, (four or five miles,) to the ridge of Calciferous Sandstone, which has been described in a previous section, as forming the Jackson Shoals.

Beyond this ridge towards the south, there is a fine tract of farming country, with considerable surface show also of limonite, for several miles, to the foot hills of the Potsdam range so frequently mentioned.

On the eastern side of the range comes the strip of Knox Dolomite, which will be discussed below.

Turning westward within four or five miles of Talladega, without crossing the Potsdam mountain, we find a broken country underlaid by the chert, all the way to Collins' Ferry on the Coosa. One exception to this may be given in Howell's Cove, a very attractive valley, lying hemmed in on three sides by sterile hills.

Where the chert prevails, as it does in the area under consideration, the characteristic features of this portion of the Dolomite (probably the upper part,) are well seen. For eight or nine miles, is a succession of hills or ridges, covered with angular fragments of chert, and timbered with a growth of long leaf pine. Of other forms of vegetation, with the exception of asters, and a few hardy plants, there is little to be seen. In the little valleys, and frequently also upon the ridges, ledges of cherty dolomite crop out, and where calcareous rocks are not actually seen above ground, their presence may be inferred from the numerous "lime-sinks" which characterize this region. In one of these "sinks," section 34, township 17, range 4, east, ledges of a fine grained drab-colored impure dolomite overhang the entrance of a cave, in which "tripoli," or fine white powdery silica, has been found; it is probably the residue from the decomposition of cherty dolomite. The rock which overhangs the cave has the characters of a good lithographic rock, though I do not know that any actual test of it has been made by the owner, Mr. Thos. A. Cook, of Plantersville.

Such a sterile soil has, of course, few attractions for the farmer, and we find the country almost uninhabited, except along the banks of the streams which water it, and these are few in number.

Further south-west a similar region in almost every respect is crossed by the road from Plantersville to Glover's Ferry.

Three or four miles north of west from Plantersville, is another occurrence of what has been called lithographic stone, on the land of Mrs. Stone.

The cherty hills in this locality are not rugged and broken like some of those further north, but gently undulating, showing only occasionally fragments of the characteristic chert.

Along the crest of a hill some 100 to 150 feet above a wide open glade, the lithographic stone is exposed in ledges, striking north 15 degrees east, and dipping 15 degrees south-east, at an angle of 45 degrees.

Just above the upper ledge of the rock, and covering it with a sharp projecting comb, like that of a roof, is a thin stratum, 10 to 12 inches thick, of calcareous shale, which weathers dark brown. The limestone itself shows a thickness of twenty to thirty feet. Some of it is exceedingly fine grained and compact, and I should be much disappointed if it will not answer well as a lithographic stone. It will probably also answer well as a cement rock.

The limestone seems to be quite free from pyrite; but the overlying shale is full of it.

From the weathered surfaces of some of the limestone, project lenticular and cylindrical concretions of hornstone, and these, detached from the limestone in its disintegration, lie scattered about the slopes of the hill, and their curious shapes have attracted much attention, and given rise to many stories of the occurrence of fossil fish, &c., there.

It is quite probable that the shales overlying the lithographic stone, will, upon closer examination, be found to be fossiliferous.

From the same formation, on Mrs. McKenzie's land, is another occurrence of lithographic stone, which has been thoroughly tested by experts, who have given very favorable

reports. Unfortunately I missed seeing this locality, and am able to give no information concerning it except at second hand. In Prof. Tuomey's time, this stone was known as a good hydraulic limestone.

West of Mrs. Stone's quarry towards the river, the land is gently undulating, but apparently not fertile, the timber being chiefly long leaf pine, with little or no undergrowth.

In section 15, township 19, range 3, east, a chert ridge ends abruptly in what is known there as the Calhoun mountain. The summit of this little mountain is about 350 feet above the level of the Coosa river. The slopes of the hill are covered with fragments of the chert full of rhombohedral cavities caused by the removal of dolomite crystals. A ledge of dolomite about three fourths of the way to summit, has been burned for lime, but it is too siliceous to make a good lime. The strata strike nearly north-east and south-west, and dip south-east.

The mountain is only about two miles long, the north-eastern end of it gradually sinks down to the general level of the elevated rolling country mentioned just above.

Near the foot of this mountain, in section 16 or 21, township 19, range 3, east, is a very large pond spring, the source of a beautiful little creek, called Clear creek, which flows into the river about three miles from its source; about one and a half miles direct distance. A large mill, (Frederick's) is located on Clear creek, a few hundred yards from its mouth. Below the mouth of the creek, at the ferry, a whitish cherty dolomite is exposed; it has been burned for lime, but like that from Calhoun mountain, it is too siliceous.

From this exposure it was difficult to ascertain the strike and dip, but the former seemed to be a little west of north, and the latter south of west at a high angle.

Some two miles east of this, on Mr. Byar's land, a fine grained siliceous dolomite is again seen, with seams or layers of hornstone. The rock here lies nearly flat, and as a consequence the strike and dip were not easily determined. As well as could be ascertained, the limestone strikes north-east and south-west, with a slight dip to north-west. If these di-

rections are correct, it would show that the disturbance caused by the uplifting of the Potsdam Sandstone, (which terminates some six or eight miles north-east,) involved also these rocks. The siliceous dolomite under consideration has been pronounced a lithographic stone, for which it may answer, if not too hard and too coarse grained. It is the property of Mr. James Burt, of Mardisville.

From here, towards Plantersville, a succession of cherty ridges is crossed. At Mr. Cook's, two miles from the town, there is a limonite bank showing very good ore, and thence on to Plantersville are many outcrops of the ore.

In S. 19, T. 19, R. 4, east, near the residence of Col. E. R. Smith, the ore is seen in considerable quantities at the base of a little hillock composed of a porous ferruginous chert.

In this neighborhood I noticed frequently that masses of friable porous chert were imbedded in the red clay of the low grounds, not being confined as usual to the ridges. Its rotten, porous character accounts for this.

The Dolomite, between the termination of the Potsdam chain at Alpine, and the beginning of another in the Kahatchee Hills, near Childersburg, seems to extend unbrokenly from the river eastward to the Blue Mountain. It is probable, though, that between the two Potsdam Sandstone ranges the fault continues, with less vertical displacement, however, since it only brings the lower subdivision of the Dolomite up to the level of the upper. This is rather a surmise than a demonstrated fact, as I am not sure that the barren cherty hills belong to the upper part of the dolomite, although such is probably the case.

It remains now to speak of the narrow strip of this formation lying between the Potsdam range and the Acadian slates. The S., R. & D. Rail-road skirts along the base of the former range for some distance, and the region now to be treated lies mostly between the rail-road and the hills or mountains to the east.

In the lower part of township 20, range 4, east, Pope Mountain forms a very prominent land-mark. It is with the region

north and north-east of this mountain that we are here concerned.

Near the junction of the Quebec Shale and Dolomite on the eastern side of the Potsdam mountain, a series of thin bedded flaggy argillaceous limestones is usually encountered. This may belong in part to the shales. At Talladega, an outcrop of it may be seen in the eastern part of the town; there it is fossilerous, though no well defined forms have been gotten from it.

At the spring in the southern or south-western edge of the town, a thin-bedded flaggy limestone (or dolomite) is seen striking north-east and south-west, and dipping at a moderate angle south-east.

Further south-west near Alpine, at Reynolds' Mill, a similar rock may again be noticed.

I have already spoken of the discontinuous character of the range of mountains of Potsdam Sandstone west of Talladega. In the gaps between these elevations the Dolomite skirts around, and very often considerable beds of limonite are found associated with it. In going from Talladega due north, the road crosses beds of the Quebec Shales, with little bands or tongues of dolomite holding limonite, and in the gap near the Poor House in sections 10 and 15, township 18, range 5, east, there is a large bank of this ore. In the immediate vicinity, on Dr. Vandiver's land, a yellow ferruginous shale is found in great quantity, showing in many places a good ore of iron.

Half a mile or more from the Poor House, on Mr. Watson's land, is another bank of ore of very fine quality.

At the foot of Mount Parnassus, a few miles north-east of this, on Mr. Bowie's farm, again limonite occurs in quantity.

At the localities near the Poor House the ore banks are shut in by the hills of Potsdam Sandstone, and its connection with the Dolomite can be seen only by tracing this around through low gaps, between successive elevations of the sandstone.

South-west of this, near Chocco Springs, the occurrence of limonite has already been spoken of, as apparently belonging to the Potsdam Group, and the same remark applies to an-

other bank on Esquire Lawson's land, near by, which is found, out in the hills of sandstone.

I refer these provisionally to the Dolomite, though their actual connection with it has not been actually demonstrated. They may *possibly* be occurrences similar to one to be described further on at Oxford, Calhoun county.

In a section across this belt now under discussion, from the sandstone hills, south-east, to the Acadian slates, we find next a succession of chert ridges and intervening valleys, which characterize the Dolomite, making up the rest of the country to the eastern limit of the formation.

Most of the soil throughout this belt is a stiff clay, colored deep red by iron, which is in numberless localities aggregated with true ore banks. This region is one of the best farming tracts in the country, for the chert ridges, though characteristic, do not cover the greater part of the country, as is the case west of the Potsdam Sandstone. It is likewise much more thoroughly charged with iron than farther west, so that this belt of the Dolomite adjoining the Metamorphic is noted for being richest in iron ore of any in the county.

Since the ore probably comes from the decomposition of a highly ferruginous limestone or dolomite, this belt shows a greater predominance of calcareous rocks than the western, and also a more thorough disintegration of the strata than that. To this wearing down of the strata may be attributed also the great quantities of clay which characterize the region. On this point see, also, above in the General Geological Summary. Before going into details respecting the occurrence of ore banks, I may here notice, that at the extreme eastern edge of this Dolomite, from Talladega Springs, north-east into Georgia, a bed of crystallized marble is found, just at the edge of the Acadian slates. This marble, in the region of the disturbance caused by the elevation of the Kahatchee Hills, is very beautiful statuary marble, and it has been described by Prof. Tuomey, and analyses have been published by him.

Further north-east, in S. 18, T. 20, R. 5, east, at Bowie's quarry, formerly Herd's, the marble lies in well defined beds, striking almost due north-east and south-west, and dipping

south-east about 45 degrees. It is white, and banded with blue; and about thirty feet thickness are exposed. Overlying it is a deep bed of red clay, with fragments of semi-metamorphic slates; and this relation between the marble and slates may be seen at any of the outcrops.

Below the marble, in the fields, there is much chert, which, however, does not exhibit so much of the angular fragments seen elsewhere; indeed, it approaches very nearly the character of a sandstone, though evidently once filled with calcareous matter, as the porous nature of the rock shows.

Again, in section 12, township 19, range 5, east, at Dr. Taylor's, and at Mrs. McKenzie's, the same marble is found under like relations. Analyses of two specimens from Dr. Taylor's quarry were given in my report for 1874, and need not be repeated here.

Above this, I have not personally examined any outcrops of the marble, though I have information of its occurrence all along the eastern edge of the Dolomite.

As to the age and geological position of this marble, there is reason to believe that it is a metamorphosed dolomite of the formation now under discussion.

In the region of the Kahatchee Hills, (see below,) this rock is more perfectly crystallized, and we find associated with it silicates of magnesia, which may have been derived from the chert and magnesia of the dolomite. Further away from this area of disturbance, we find the metamorphism less perfect, though still very considerable, caused by the uplifting of the Metamorphic hills to the east.

We may reasonably expect some day to see this belt of marble become valuable property. At present there is little demand for it, though some years ago quite an extensive business was carried on by Dr. Gantt, Mr. Nix, Messrs. Herd, and others.

We may now take up the occurrences of limonite. The geological features of this belt, are much the same throughout, so that the description of a few localities will suffice for all, it being borne in mind that I have been able to examine a few only of the more prominent ore banks.

A short distance north of Bowie's marble quarry, and in section 1, township 20, range 4, east, and section 6, township 20, range 5, east, on the road to Talladega, is a long red hill, on which is the residence of Mrs. Hannah E. Reynolds. All along the sides of this hill smooth pebbles of limonite, and also larger fragments abound. Beyond the house, in section 6, a large field, inclosing about one square mile, is literally covered with the ore.

I have not as yet been able to obtain an analysis of the ore from here, but this omission will be filled in a subsequent report. I have very little doubt that the ore will prove to be of the best quality.

Specimens of this ore show all the varieties of compact fibrous, ochreous, &c.

The hill upon which the greater part of the ore is found affords a fine site for the erection of a furnace, as it overlooks a little creek, and is not far distant from the band of marble which will afford an admirable material for the flux.

Arrangements were in fact made some time since for the erection of a furnace here, and the day is probably not far distant when it will be built. Transportation is always an item of the first importance in such undertakings, and the proposed rail road from Syllacauga to Talladega will bring this point in direct communication with the market, and the speedy utilization of the stores of marble and iron ore will be the natural result.

Between Mrs. Reynolds' and Talladega are many valuable plantations and beautiful country residences, and this might well be called the garden-spot of the county.

At the old town of Mardisville, a sandy, flaggy dolomite crops out in the road in many places, and in the midst of the town is one of those beautiful springs of clear water, which abound in this formation, so far as it has been examined from Bibb county to Calhoun. The dolomite at Mardisville, is in some places nearly a sandstone, and large masses of chert, porous from the removal of calcareous matter, are abundant in the red clay soil. As might be expected with such associations, pebbles and fragments of limonite may be noticed

along the road side for half a mile or more. I have not visited any ore bank at this place. The flaggy dolomite in Mardisville strikes north and south, and dips at a moderate angle towards the east. The wagon road over these edges of strata, and broken off pieces, is anything but good, and it is quite noticeable as being almost the only piece of bad road from Syllacauga to Talladega. About four miles east from Talladega, in section 29, township 18, range 6, east, there is a large pond spring several acres in extent, from which flows a tributary to Choccolocco, and a mile further, another spring, the waters of which flow south-westward into Talladega creek.

In the south-east corner of the township, and within a mile of the hills of Acadian slates, are two fine iron ore banks, one known as the Seay Bank, section 35, and another, the Irona Bank, sections 26 and 27, the property of Mr. M. H. Cruikshank of Talladega. The two deposits are almost, if not quite continuous. The ore from this place was used many years ago in the old Rob Roy Forge, and the locality, as well as the ores described by Prof. Tuomey. I have, in addition, two analyses, by Mr. J. B. Britton, of ores, and one of forged iron, from this place. To the courtesy of Col. S. S. Glidden of the Alabama Furnace, I am indebted for the analyses.

No. 1. Ore from the Seay Bank.

Combined Water	11.86	
Siliceous Matter, insoluble	7.39	
Soluble Silica	0.19	
Ferric Oxide	77.54	—54.28 Metallic Iron.
Alumina	2.07	
Lime	0.07	
Magnesia	0.03	
Phosphoric Acid	0.29	—0.13 Phosphorus.
Sulphur	None.	
Manganese undetermined, & loss	0.56	
Total	100.00	

100 parts Metallic Iron contain 0.221 Phosphorus.

No. 2. Ore from the Irona Bank.

Combined Water	11.52	
Siliceous Matter, insoluble	11.62	
Soluble Silica	0.09	
Ferric Oxide	68.93	—48.25 Metallic Iron.
Alumina	3.59	
Manganese	3.77	
Lime	0.10	
Magnesia	0.05	
Phosphoric Acid	0.13	—0.06 Phosphorus.
Sulphur	None.	
Undetermined, and loss	0.20	
Total	100.00	

100 parts Metallic Iron contain 0.124 Posphorus.

No. 3. Forged Iron from Ore from Irona Bank.

Metallic Iron	99.020
Carbon	0.198
Silicon	0.265
Sulphur	.000
Phosphorus	0.122
Manganese	0.064
Undetermined, and loss	.331
Total	100.000

These analyses show sufficiently well the character of the ore, especially as they were made from *average samples* collected by Col. Glidden. Whilst analyses from average samples may not always make so fine a showing as those from picked specimens, yet they are the only analyses of much value in giving an idea of the *general quality* of an ore bank.

Good limestone is near at hand, and the forests of pine surrounding the ore beds will yield fuel enough for many years. The extent of this deposit is very great, and it lies about four or five miles distant from the rail road.

Most of the way from this ore deposit up to the residence of Col. McElderry, in S. 11, T. 18, R. 6, east, outcroppings of limonite may be seen by the roadside, and on the left are ridges of chert.

On the Selma, Rome & Dalton Rail Road, in section 17, township 17, range 7, east, is the Alabama Furnace, Col. Stephen S. Glidden, Superintendent.

The ore banks are in sections 16 and 17, and cover an area of about one mile square. The limonite is of the usual character. Towards the west the ore is purer, but in the eastern and southern portions of the field there is mixed with the good ore much that is cherty, and a good deal of the porous friable chert that we have met with so frequently.

As to the thickness of the deposits, I can say but little. I saw myself no pits deeper than fifteen feet, though I was told by one of the contractors, that the light-colored yellow sand, below which they had found no ore, has been reached in several places, at depths varying from 15 to 20 feet.

I have no analysis of any of the ore from these banks, but the iron made from it meets with a very ready sale.

The limestone at present is gotten from a layer in the dolomite of this formation, in section 18, near the furnace. The beds strike north-east and south-west, and dip south-east. The greater part of the rock exposed at the quarry is a compact bluish limestone, or rather dolomite, as shown by the analyses given below. Some of the beds are of a gray color, and a band or seam of hornstone traverses part of it.

The analyses are by Mr. Britton, and I am enabled to publish them through the courtesy of Col. Glidden, for whom they were made.

No. 1. Limestone from S. 16, T. 17, R. 7, E., Talladega Co.

Carbonate of Lime	55 35
Carbonate of Magnesia	34.58
Siliceous Matter, insoluble	7.75
Iron and Alumina	1.48
Water, and loss	0.84
Total	100.00

No. 2. Another Limestone from same locality.

Carbonate of Lime....................	61 86
Carbonate of Magnesia.	33.55
Siliceous Matter, insoluble.............	2.86
Iron and Alumina.....................	1.09
Water, and loss.......................	0.64
Total........................	100.00

During my last visit to the Alabama Furnace, it was out of blast for the purpose of re-lining, and a large quantity of a peculiar furnace scale had been taken out of the stack.

A specimen of this scale, analyzed also by Mr. Britton, showed the following composition in 100 parts:

Furnace Scale.

Silica................................	1.46
Iron and Alumina.....................	3.62
Zinc Oxide, Cadmium Oxide, }	91.70
Graphite, and undetermined...........	3.22
Total........................	100.00

Showing it to be almost entirely a mixture of zinc and cadmium oxides, the zinc oxide being by far the more abundant of the two.

The presence of zinc in furnace scale from Benton county was noticed by Prof. Mallet in Tuomey's Report, (probably the same locality with this.)

It is noteworthy that none of the iron ores, or of the limestones analyzed from here, show the presence of zinc, which must therefore exist in very small quantities, probably, in the limestone. Perhaps if these should be carefully tested for zinc, its reaction might be detected.

Economic Materials and Iron Industry of Talladega.

In the geological details above, I have given some account of the principal deposits of limonite in the county which I

have personally examined; and I shall not repeat them here. The localities where limestone supposed to be suited to lithographic purposes, have also been given. I might add, in this connection, that near Dr. Taylor's, in section 11, township 19, range 6, east, there is an occurrence of fine grained rock which has been thought to be lithographic stone. I have not seen it.

Springs.—Of the numerous bold springs which characterize this formation, several have been mentioned already. On Mr. Bowie's plantation, section 27, township 19, range 5, east, there is another, and on the S., R. & D. R. R. another, Kelley's spring; but to enumerate all the beautiful springs with which this formation abounds would be impossible.

Iron Industry.—At present, there is but one blast furnace in the county, the Alabama Furnace.

This furnace is owned by the Alabama Iron Company, S. S. Glidden, President and Superintendent, and James L. Orr, Treasurer.

It was started October 1, 1873, having been rebuilt on the site of a furnace destroyed during the war. There is only one stack, 41 feet high; 8 feet 8 inches across the bosh; open top; hot blast; 3 blowing cylinders, 40 inches in diameter, and 6 feet stroke; steam cylinder 21 inches in diameter, and 6 feet stroke; fuel, charcoal; ore, brown hematite; ore beds about half a mile from the furnace; limestone about the same distance. Furnace yields from 20 to 22 tons of foundry iron per day.

This furnace, though a small one, yields as well as any in the State. The charcoal is burned in ordinary kilns upon the grounds, and the ore also is roasted at the furnace, so that all the operations, except the raising of the ore, and the quarrying of the limestone, and cutting of the wood, goes on under the eye of the superintendent.

Of the future of Talladega county in the production of iron there can scarcely be two opinions. The belt of dolomite next to the semi-metamorphic hills, holds ore enough for an immense industry, and whilst other regions of the county are not so much favored in this respect, yet there are furn-

aces running in other counties upon ore banks not more extensive than some of those enumerated above.

Want of transportation stands in the way of the improvement of many of these localities, and the present low prices of iron and bad market, are already seriously felt at several of the furnaces in the State already erected.

Kahatchee Hills.

Under this heading I shall speak of the geology, &c., of that part of Talladega county lying southwest of a line from Childersburg to the southeast corner of township 20, range 4.

Topography.

In the southern part of the township designated above, the Pope Mountain makes a very prominent feature in the landscape. Three miles south of this mountain, a range of hills may be observed striking nearly due west, at first a single chain of hills, but beyond Oden's Mill, S. 13, T. 20, R. 3, E., widening out towards the northwest and southwest, making a very broken country to the Coosa. Tending southward, from near the Coosa bridge, (crossing of the S., R. & D. R. R.) for several miles, another chain of hills makes the western boundary of this region, and in the extreme southwest corner of the county, the high hills surrounding the Talladega Sulphur Spring, marks the limit of it in that direction.

The Tallasseehatchee flows from the hills of semi-metamorphic slates of the Acadian group, eastward in the low valley between Pope Mountain and the East and West Range spoken of, and then turns northwest to the Coosa, into which it empties a few miles northwest of Childersburg.

Cedar Creek, rising just south of the East and West Range, near the town of Syllacauga, flows westward into the Coosa, between the western range of hills, and those surrounding the Sulphur Springs. This creek receives one tolerably large tributary, the Kataula Creek, from the high hills of the East and West Range in Township 20, Range 3.

Having its source in the same high hills, and at no great distance from the head of Kataula, but on the opposite side of the mountain, the Kahatchee flows westward between two prongs of the East and West Range, then northward and westward around the ends of these prongs into the Coosa below Coosa bridge. The Coleman Fork of Kahatchee rises near the source of the latter, flows however along the northern edge of one of the hills, Kahatchee being South of the same, and joins the main creek two or three miles above its mouth. Another small tributary to Kahatchee is found still further northward.

The courses of Tallasseehatchee Creek and its tributaries are worthy of more particular notice. The principal tributaries are Wewoka and Emaughee creeks, draining from the North; and Short and Crooked creeks from the South, whilst the head waters of the Tallasseehatchee proper, far up in the hills of Acadian Slates have a general westerly course for eight or ten miles.

The Wewoka rises near the western edge of the Acadian Hills and flows into Tallasseehatchee after a sinuous, but in general, westerly course. It cuts through a chain of hills connecting the western extremity of the Pope Mountains with the end of the chain of Potsdam Sandstone at Alpine.

Corresponding to it on the south, Short Creek rises south of the East and West Kahatchee chain, cuts through it at Oden's Mill, and joins the Tallasseehatchee after a short northerly course of six or eight miles.

The Emaughee and its branches, have their headwaters far to the north and east. as high up as T. 19, R. 5, E. In their courses they traverse almost the entire series of Acadian Slates, rising, however, west of the high Quartzite ridge of Blue Mountain, which is, probably, metamorphosed Potsdam Sandstone. Flowing southwest, the Emaughee passes out from the Acadian slates into the Dolomite, between the Pope Mountain and the East and West Kahatchee Range, then flows westward, joining the Tallasseehatchee between those mountains, and three or four miles west of the slate hills.

Similarly, Crooked creek, with its branches, rising far south,

three or four miles beyond Syllacauga, and likewise near the quartzite ridge of Rebecca Mountain or Blue Mountain, flows northeast through Acadian slates, crossing almost the entire belt of them, emerges near the end of the East and West Kahatchee chain, at the falls at Vincent's Mill, and a short distance below that it joins the Tallassahatchee.

As was intimated above, the Tallassahatchee proper has its sources, like the others, just at the foot of the quartzite ridge, traverses the whole series of Acadian slates, almost directly across the strike, and enters the Dolomite near Vincent's Mill.

Wherever I have visited the points where the creeks of this county come from the slate hills into the Dolomite, attractive cascades were seen.

The Tallassahatchee, then, reinforced by the waters of Emaughee and Crooked creeks, having thus all the drainage from the western side of the main quartzite ridge of Blue Mountain, from township 19, range 5, east, as far south as township 22, range 4, east, flows westward between the two mountains so often spoken of, receives the water of Short creek, then turns northward and then northwest, to the Coosa, receiving the Wewoka and one or two other smaller streams, which drain the dolomite belt, the Wewoka rising just in the edge of the slate hills.

The Tallassahatchee, unlike Talladega creek, is a short stream, the distance from its source to mouth in a straight line being not much more than eighteen or twenty miles; but near the slate hills it sends out its long feeders, the Emaughee and Crooked creeks, and collects the waters for many miles north-west and south-west.

Talladega creek, as was stated above, rises far out amongst the Metamorphic hills, cuts through the quartzite of Blue Mountain, crosses the Acadian slates, but receives very little accession to its waters west of the quartzite ridge.

The hills or mountains of this region, which are elevated 500 to 800 feet above the level of the plain, are often very steep and precipitous, especially on that side where the broken edges of the strata overhang the plain. Between the indi-

vidual mountains which make up the region patches of level fertile farming land are frequently enclosed, and, protected by the high mountains from too abrupt changes in the weather, such areas are sometimes favored spots, where fruit and growing crops flourish long after blighting frosts have fallen upon adjoining tracts.

Geology.

The geological formations represented in this area are—

(1). The *Acadian Slates and Conglomerates*, on the east. Possibly, also, some of the semi-metamorphosed slates found on the flanks of the mountains may belong to this group, though they belong chiefly, I believe, to a higher group.

(2). *Potsdam Sandstone.* This makes the mass of the mountains, the sides of which show usually outcroppings of

(3). *Calciferous or Knox Sandstones*, sometimes half-metamorphosed; and lower down in the edges of the valleys, (4) the slates of the *Quebec Group* likewise, also half-metamorphosed, though sometimes unchanged. The greater part of the low lands and their cherty ridges, together with the metamorphic crystalline limestone, or marble, lying next adjoining the Acadian, I have referred to (5) the *Dolomite* division of the *Quebec Group*. I have reason to believe that (6) the *Black Shale* is to be found at the foot of the Potsdam Sandstone ridge near the Sulphur Springs, and also at another point five or six miles south-west of Childersburg.

With this enumeration of the formations, I shall go on to describe in detail this region as a whole, and not, as heretofore, the formations *seriatim*.

Since the Pope Mountain, above referred to, is a prominent object, and as its structure is characteristic, it will form the starting point of our description.

The old plank road crosses this mountain in sections 27 and 33, township 20, range 4, east, near the residence of Mr. S. B. Glazener; the place of crossing being a comparatively low gap between two knobs, one east and one west of the road. The mass of the mountain is made up of a siliceous sandstone with occasionally some fine conglomerate. On the summit of

the knob to the west of the road, we find these sandstones heavy bedded and having all the distinctive features of the sandstone of the Potsdam chain further north, except that I have not discovered, as yet, any traces of the peculiar *scolithus rods*. The strata strike nearly due east and west, and dip north. Upon the summit, associated with the heavy bedded sandstones and conglomerate, are great quantities of thin and thick bedded sandstones, impregnated with magnetite to such a degree that fragments of the rock show strong polarity. The usual color of these magnetite-bearing rocks is gray, though after long exposure the color is usually darker, sometimes approaching to black. Besides these, we find on the knob east of the road many pieces of sandstone with lamellæ of an iron ore which has the appearance of specular ore, without, however, its red streak.

This metallic substance is found as a crating, sometimes half an inch or more in thickness, and the richest specimens usually show very little polarity, often none at all. These heavy bedded sandstones and conglomerates I have referred to the Potsdam Group. Coming down the southern face of the mountain, sandy semi-metamorphic slates are first passed over, and then a very siliceous limestone or dolomite, alternating with strata of a shaly limestone, (the shaly parts so altered as to resemble the talcoid slates of the Acadian group.) Some of the limestone is pure white in color, and of compact texture, but upon weathered surfaces it is seen to be chiefly siliceous matter. The limestone beds exposed on the hill-side (30 to 40 feet in thickness) seem to vary considerably in their contents of silica; none of it, however, has been found pure enough to make good lime. Below these beds are fragments of semi-metamorphic slates, with more abundant fragments of sandstone, similar to that at the summit, down to the foot of the hill, where the Dolomite and its chert of Quebec Age begin and fill the interval between this and the mountain three miles further south.

Below the limestone I saw no rocks in place, and the fragments of slates and sandstones covering the ground may have rolled down from above.

Some of the difficulties in deciding upon the ages of the rocks entering into the structure of Popé mountain, may as well be set forth here, since the same difficulties are encountered elsewhere in this interesting region. If the sandstone and conglomerate at the summit of the mountain be Potsdam, then in coming down the southern slope, and crossing the strata in a descending sense geologically also, (since they all dip northward,) we find under the sandstone a series of sandy semi-metamorphic slates, possibly Acadian, and below these and dipping under them, the siliceous limestone, the shaly strata of which have been changed into semi-metamorphic slates very much like those just above. The limestone is found more than three-fourths of the way up from the foot of the mountain, and, consequently, not very far from the summit. The strata of dolomite, &c., unchanged, lie in the valley enclosed between two ranges of these hills. If the white siliceous limestone and slates, belong to the Dolomite, as I am inclined to think they do, then they have been involved in the mountain making, have been partially metamorphosed, and are separated from the Potsdam strata, which they *appear to underlie*, by a fault which is not far from the crest of the mountain on its southern face.

Going northward over the mountain we cross nothing but the sandstones to the foot of the mountain, when the Dolomite is entered and it continues to be the prevailing formation northward and eastward to the Potsdam chain west of Talladega. I did not notice any rocks which resembled the Calciferous sandstone and Quebec shales, on this northern slope, but as my observations were confined to a very limited area, I presume that upon closer examinations they would be found.

In section 36, township 20, range 4, east, or opposite the eastern end of Pope mountain and between it and the hills of the Acadian slates, are the marble quarries formerly owned by Mr. J. M. N. B: Nix, and Messrs. Herd; at present the property of Mr. Bond. The quality of this marble was investigated by Prof. Tuomey and his analyses and report upon it are sufficient proof of its excellence. The stone has been

quarried in several places and exhibits several varieties, pure white, light blue, banded blue and white, and dark blue.

It is very evidently bedded, and the stratification planes are utilized in the quarrying. Upon the surfaces of these bedding planes, which strike due north-west and dip 5 deg. to 15 deg. north-east, are marks of joints which cross each other at an oblique angle, two to four feet apart, thus dividing the marble into rhomboidal blocks.

How deep these joints extend is not known, as very little marble has yet been gotten except at the surface. The rock is much water-worn. More than fifty feet thickness of solid marble are here laid bare.

Above it come heavy layers of irregularly bedded curly, knotty, shining greenish slates of the Acadian group, hydro mica (talcoid) slates. At one point some twenty feet thickness of these slates can be seen directly super-imposed upon the marble, and, so far as the dip, &c., go, *conformably*. If, however, as is supposed, the marble belongs to the Quebec Dolomite, the Acadian slates have been pushed over upon the Dolomite, having been displaced by a fault. In section 1, township 21, range 4, east, half a mile or more south of the above occurrence, marble has also been worked in times past. In the same section, near the residence of Mr. Frank Sherrill, are occurrences of smooth, fine grained, fissile slates, of a bluish drab color, from which roofing slates may possibly be obtained. No explorations have been made for the slates, and all I saw were weathered surface specimens. These were rather soft, and not fissile enough to serve the purposes of a roofing slate, still, better ones may be uncovered. The slates are similar to those occurring west of Dr. George Hill's, further south, and with those I have considered them to be slates of the Quebec Group, partially metamorphosed.

In the strike north-west and south-east, and dip north-east of the marble, and overlying slates, it will be seen that the strata appear to *bend around* the end of the Pope mountain, the strata of which strike east and west. This point will be noticed again below in speaking of the range of hills next crossed in going south.

From the western end of Pope mountain a chain of hills extends nearly due north to the end of the Potsdam chain at Alpine.

Wewoka creek cuts through this range near section 16, township 20, range 4, east. Of the structure of these hills I can say nothing from personal observation, though I suspect that they are of the same nature with the Pope mountain.

Going southward from Pope mountain, across the valley through which flows the Tallasseehatchee, a second range is crossed near the middle of township 21, range 4, east. This chain begins in section 15, township 21, range 4, and strikes due west, as far as section 15, township 21, range 3, east, then widens out towards the north-west and south-west making the Kahatchee Hills. The east and west chain is crossed by the plank road, at what is known as the plank road gap, in section 16, township 21, range 4, east, and is cut by Short creek at Oden's mill, section 18, same township and range.

At the eastern extremity of this range, where it comes close to the hills of Acadian slates, Crooked creek, which rises amongst the Acadian slates several miles south or south-east of Syllacauga, and flows north-east into the Tallasseehatchee, tumbles over the rocks in a series of cascades at Vincent's mill. This is a locality which promises to reveal some facts of interest and will be more particularly examined at a future time.

In the plank road gap the following section of rocks is exposed, in *descending order* from south to north:

1. Dolomite and chert of the Quebec formation—at foot of mountain.

2. Flaggy sandstones in fragments covering the southern slope—no rocks seen in place.

3. Very near the summit semi-metamorphic slates, like many slates of the Acadian group.

4. Below the summit, on northern side of mountain, and directly under and conformable to the slates, are limestones, often impure cherty, and shaly, (shaly layers semi-metamorphic or talcoid slates,) and alternating with light colored

shales—whole thickness of the limestone strata thirty to forty feet.

5. Below this the rocks pass into shales, and lastly into sandstones, like those seen on the southern slope of Pope Mountain.

6. In the valley of Tallassahatchee, Quebec Dolomite.

These rocks strike east and west, and dip south.

The similarity of the strata here crossed and those forming Pope Mountain can not fail to attract notice. The two mountains are parallel, and their strata dip in opposite directions from each other, with a Dolomite area between, as though they formed parts of an anti-clinal fold. The structure of the country at the eastern extremities of these two mountains, when more closely examined, may throw much light upon this point.

At the plank road gap, very little of the sandstone and conglomerates which characterize the summit of Pope Mountain, are shown, but to the east and west of the crossing, upon the higher points, these rocks, as well as the associated magnetite-bearing sandstone, are quite as abundant as there. The limestones alternating with semi-metamorphosed slates, and lying directly under a heavy bed of these slates, are repetitions of what were seen at the Pope mountain.

Following this East and West Chain to where Short creek cuts through it at Oden's Mill, another very good section may be obtained. Remembering that the strike is east and west, and the dip south, we find north of the ridge a rolling area of Quebec Dolomite; at the foot of the hill are sandy semi-metamorphic slates, with white cherty limestone, (quarried for lime east of the mill, but too flinty to make a good article.) This limestone, with its slates, may be seen near the summit, and following it are heavy-bedded sandstones, and with this, a stratum (2 to 3 feet in one place where cut through in making a road,) of solid sandstone charged with magnetite, many fragments of it showing strong polarity.

The southern slope of the hill is made up chiefly of greenish, soapy-feeling half-metamorphosed slates, a little less crys-

talline than the so-called talcose slates, but otherwise very much like them.

Below these slates, with which sandstone ledges are often associated, we come upon cherty dolomite once more.

This section, like that over the mountain at the plank road gap, is at a low place, and the structure of the mountain at these two places differs slightly from that at the Pope Mountain, and also at the high points westward which remain yet to be described.

I am free to confess, that the exact relations of these rocks are not altogether clear to my mind, and that whilst I can refer the heavy-bedded sandstones and conglomerates, making up the main mass of the mountains, to no other horizon than that of the Potsdam Sandstone, the thin beds of half-metamorphosed slates under them, and they in turn underlaid by alternations of limestones and similar semi-metamorphic slates, are quite confusing, though all that I have observed in this region makes the explanation given above, in considering Pope Mountain, appear to me most probably the true one.

From Oden's Mill westward for three miles, the ridge is a single one; but near S. 15, T. 21, R. 3, east, it divides into three or more distinct ridges, north-west, west, and south-west, respectively, and become dividing ridges between Kataula, Kahatchee, and Coleman's Fork. In S. 16, T. 21, R. 3, east, on the summit of the mountain, there is a depression called the Dry Pond, which at certain seasons of the year is filled with water, which drains off towards the south into Kataula, and towards the north into Kahatchee. This Dry Pond is near the point where the undivided range terminates, and the branching begins.

The most northerly of these branches curves off first north-west, and then nearly north, making a sort of arc of a circle. It has the highest peak in this vicinity, that just back of the residence of Mr. Albert Crumpler, and as it has no other name, I shall call it Crumpler's peak. Its elevation above the rail road level at Childersburg is 800 feet, and on that side overlooking the plain towards the east and north, it is very steep and precipitous, many places near the summit showing

an exposure of sandstone cliffs many feet in thickness. The structure of this mountain is a type of that of all the others in the region, and I shall therefore give it more in detail.

The summits of this and other ridges of the kind are quite irregular, some points being 200 to 300 feet higher than others. The highest points are always covered with huge blocks of sandstone, piled in confusion upon each other, so that an undisturbed ledge, or one in place, is not very often seen.

In the lower places a kind of shaly sandstone, sometimes almost shales, are always found. These shales have a brownish yellow color. It is rather strange to meet with this alternation of harder and softer strata in going *along* the *strike* of the rocks. Such alternations would naturally be found in going *across* it. The strata here dips towards the south, southwest, and west, according to the direction of the strike. Below the summit on the east and north sides, and geologically below the sandstone, are sandy half-metamorphosed, greenish slates; then limestones partly gray and cherty, partly blue, with argillaceous bands, and partly a very fair blue limestone that makes an excellent lime. Below this again the partially metamorphosed slates like those above, passing downwards into the unchanged dolomite of the valley.

A section showing the actual contact of the sandstones with the slates, I did not see on this ridge, though such an one has been described above at the Pope Mountain, with which this has many points in common.

Northward from Crumpler's Peak, and a mile or two only from Childersburg, similar sandstones and greenish half-metamorphic slates make up a small ridge about 350 feet in height above the rail road level.

These sandstones and slates at the point where I observed their outcrops, section 30, township 20, range 3, east, strike north 15 degrees east, and dip about 5 degrees towards the south-east. With the rocks above mentioned are found also fragments of the sandy magnetic rock seen at Oden's mill, Pope mountain, &c. Upon Crumpler's peak I saw none of the latter rock. In section 31, just south-west of the locality described, is a large bank of what appeared to be a very good

limonite. Still further south-west, in section 36, township 20, range 2, east, upon the sides of a cherty ridge, is a fine exposure of cherty sandy dolomite of the Quebec Group, which thus fills in the interval between ridges of Potsdam Sandstone.

To return now to Crumpler's peak. Between this, and the next spur of the ridge towards the south, flows the Coleman fork of Kahatchee. After descending the mountain the country between the ridges is generally Quebec Dolomite, though curly, hydro mica slates are generally found upon the flanks. I have information, which seems to be tolerably reliable, that in section 7, township 21, range 3, east, there is an occurrence of what has usually passed for coal, but which is, in all probability, the Black Shale. Between the middle spur and the southern one flows the longer branch or fork of Kahatchee, through a tolerably narrow ravine. These two spurs or branches of the main East and West Chain, die out or sink down to the general level of the country about a mile west of the range line, between ranges 2 and 3, so that the road from Fayetteville to Childersburg, whilst it crosses this mountainous country, appears to be nearly level all the way. Towards the western extremities of the spurs above mentioned, little cross ridges are quite numerous. These are frequently seen along the Kahatchee creek, and they are composed chiefly of semi-metamorphic (talcoid) slates, often inclosing lenticular lumps of quartz. In two or three places I observed the strike of north 10 degrees west, and a steep dip to the north-east. The Fayetteville and Childersburg road lies principally over Quebec Dolomite, which, as I have said above, fills in the spaces between the main elevations of Potsdam Sandstone. West of this road, may be seen another considerable range of hills, extending from just south of the mouth of Kahatchee, and approximately parallel with the course of the Coosa river, southward to the hills or mountains which surround the Sulphur Springs.

This is not a continuous chain, but a series of high points alternating with lower places. Cedar creek cuts through it. At its northern extremity, just south of Coosa bridge, in sec-

tion 3, township 21, range 2, east, it has an elevation of some 375 feet. This mountain, like the others, is composed of massive sandstone, and these were so much broken up by joints that I could not be certain of the dip; the strike is probably that of the axis of the ridge. Upon descending this ridge towards the east, *i. e.*, towards the Fayetteville and Childersburg road, a narrow belt of unchanged Quebec Shales, with the usual bright and agreeable colors, is crossed, and then the dolomite of the low grounds. Further south than the point where I visited this hill, the magnetite-bearing sandstone has been found in abundance.

In the dolomite which fills in the spaces between the spurs and ridges above named of the Potsdam Sandstone, is always found more or less of good limonite. The localities where it occurs in large quantities are numerous. At Fayetteville Cedar creek flows over great masses of gray Cherty Dolomite of the Quebec Group, and close to the ford, a little ridge of half metamorphosed slates, juts up very abruptly through the dolomite. North of Fayetteville, a similar ridge of slates is crossed, then another expanse of dolomite, after which begin the hills proper, which, as I have already noticed, are at the crossing of the road, not much elevated. These hills are chiefly of sandstone, as I interpret it, of the Potsdam Age; but where the road crosses Kahatchee creek, a ridge or hill of semi-metamorphic slates comes down nearly to the water's edge, so that the road has to be cut out for some distance.

The geological position of these slates, I am unable to give with certainty. They are of the same nature with many of the slates of the Acadian Group; perhaps not, altogether so much metamorphosed, and a little more sandy. Some of them may be Acadian, though others, from their position, should be altered Quebec Shales, or, perhaps, Calciferous or Knox Sandstone. It will require much time and careful observation to settle many geological questions presented in these hills.

The region just described embraces the Kahatchee Hills proper, but there is a part of the county south and southwest, so intimately connected with them in the foldings and

disturbances of the strata to which they owe their origin, that they will be considered together.

Southward from the Plank Road Gap, towards Syllacauga and the Sulphur Springs, the road is a remarkably good one, lying over Quebec Dolomite, which is tolerably free from the cherty ridges which characterize portions of it.

Near the edge of the Acadian slates, from Vincent's mill to Syllacauga, and beyond that to Gantt's quarry, a bed of crystalline white marble is found. In a well at Mr. Hubbard's, in Syllacauga, the marble lies at a depth of twenty-eight feet from the surface. In section 21, township 21, range 4, east, at Mr. Fluker's, on or near the summit of a low hill is a stratum, about ten feet thick, of calcite, enclosed between heavy beds of quartzite, all striking north-west and south-east and dipping north-east. The calcite is well crystallized and breaks readily into cleavage fragments of large size. The continuation of this bed north-west, only ten feet distant, shows simply a stratum of very pure blue limestone. South of this, about twenty yards, another exposure of light gray limestone is seen, and in a well almost in the continuation of the strike of the calcite stratum, very good marble has been reached, whilst north of the same another exposure of fine-grained, almost crystalline limestone.

The hill thus appears to be made up of a succession of beds of quartzite and limestone, hardened and crystallized by metamorphic action. The change in the texture of the first stratum described, from compact, to crystallized, within the distance of a few feet, is noteworthy.

The position of these beds, less than a mile from the east and west ridge of Potsdam Sandstone, and within two miles of the termination of the same towards the east, may have some significance. Along the southern face of the latter range of Potsdam rocks, and in the valleys skirting the foot of the hills, are several localities of slates which have been worked to some extent in the hope that they might prove to be good roofing slates.

South-west from Oden's mill, in section 22, township 21, range 3, east, are outcroppings of such slates quite fissile and

smooth-faced. The color is a light gray or drab. Dolomite or limestone is found in close proximity with these slates, and if their relative positions are not disturbed by faulting, the limestone is *under* the slates. Further south-west the same slates show still better, and they are generally not far from a yellowish fine-grained and tolerably soft sandstone, which was used by Col. Hill during the war for making grindstones. This sandstone seems to lie under the slates also.

West of this, in section 21, are several quarries from which large quantities of slate were dug, and, I believe, shipped to the market. The slates are quite fine-grained and fissile; the beds strike north-east and south-west, and dip 6 to 10 degrees south-east. They are traversed by two sets of joints, one running north-north-east and south-south-east; the other east-north-east, and west-south-west, dividing the slates into rhomboidal blocks, which are some twelve to eighteen inches in dimensions. Going south from the slate quarries we cross the ridge of sandstone which furnished material for the grindstones alluded to above, and as the dip of the strata is south-east the sandstone is *above* this belt of slates, though apparently below that spoken of in section 22. A very short distance south of the sandstone ridge, in section 26, township 21, range 3, east, a tolerably good section of the rocks, is exposed, which I give, in *descending* order:

1. Bluish, curly, arenacious slate.... ....3 to 4 feet.
2. Dark blue, flinty limestone, much hacked on weathered surface, tolerably massive........ 15 feet.
3. Shaly, black limestone......................5 to 6 feet.
4. Compact, white flint, slaty below............. 4 feet.
5. Light gray, flinty limestone or dolomite of undetermined thickness.
6. Below this, to the bottom of the hill, fragments of semi-metamorphic slates, somewhat sandy.

The dark shaly limestone is fossiliferous, but no fossils were determinable.

From a stratum on a hillside, on the opposite side of the road from where this section was taken, very good limestone, for lime burning, has been obtained.

Whilst the geological equivalency of the slates and sandstones, and of the strata of the section above are not perfectly clear, yet I am strongly inclined to the opinion that they belong to the Calciferous or Knox Sandstone, and Quebec Shales. The limestone and slates, with a heavy bed of sandstone between, are probably of Calciferous Age, Knox Sandstone, whilst the limestones, semi-metamorphic slates, &c., of the above section, are more probably of the Quebec Shale.

Near Dr. Hill's residence a stratum of fine grained black limestone, with veins of calcite, which receives a handsome polish and is a fine black marble, has been utilized to some extent, and table tops, mantles, and other articles of a similar nature, made from it, are very beautiful.

South of Dr. Hill's, in section 2, township 22, range 3, east, is Gantt's quarry, where so much of the beautiful marble of Talladega has been obtained. The property is at present lying idle.

As I remarked above, this belt of marble will probably be found to be Quebec Dolomite, metamorphosed. Its position, and the associated minerals, chiefly talc and other magnesian silicates, all point to this view. Towards the south-west, the marble has been found and worked at Mr. Cooper's (section 12, township 24, range 16, east, of the lower survey,) in Coosa county. At this place, also, it lies at the edge of the hills of Acadian slates, and shows the usual varieties, white, blue, and banded.

At Syllacauga, which is finely located on high ground, with a good view of the Metamorphic mountains towards the east, the Quebec Dolomite, the country rock, is charged with iron, and fragments and masses of limonite are found everywhere. Some of these occurrences were interesting, since they were well-defined pseudomorphs of limonite after pyrite. The crystalline form is usually the cube, without modifying planes. Most of these cubes, when broken open, show a nucleus of unchanged pyrite. Mr. Gothard's, just east of Syllacauga, is a locality from which many were obtained.

Near Mr. Simon Morris' are great quantities of brown ore,

quite sandy, however, upon the surface. No explorations have been made to test the quality of the ore below.

A few miles north of Syllacauga, near the base of the mountain with its magnetite-bearing sandstone, beds of limonite are found in sections 16 and 20, the latter on land belonging to Mr. J. K. Oden.

Going south-west from Syllacauga, the road is over the Dolomite, which is highly ferruginous, and surface specimens of limonite abound everywhere.

At Mr. Averitt's, about section 5 or 6, township 22, range 3, east, there is a very extensive exposure of Quebec Dolomite, from under ledges of which boils up a magnificent spring.

The dolomite is gray, sandy, presenting a hacked appearance upon weathered surfaces. It is the characteristic dolomite of this age.

South-west from Averitt's, rise the mountains which surround the Sulphur Springs, and make such an attractive feature of the landscape.

These mountains have already been referred to, incidentally, as forming the continuation, south of Cedar creek, of a range of Potsdam Sandstone running south from near Coosa Bridge, and approximately parallel with the river. The road from Fayetteville to the Springs, after passing for some distance over the red clay soil of the Quebec Dolomite, leads through a very low gap in this mountain, hardly raised above the general level of the country. South of this road the mountain has a course first south for a mile or more, then curves around gradually towards the south-west, having nearly that direction where it forms such a grand back-ground to the scenery at the Springs.

The following section of the rocks composing the mountain south of the springs may serve to give an idea of its structure: "The springs are situated in a valley closed in on three sides by hills. On the south and east the hills are high and precipitous on the side overlooking the spring."

A little branch flows down towards the north-west from between these two hills, and at the Springs it passes over ledges of dolomite, and it is from between the strata of this rock that

the waters of the Sulphur Spring seem to rise. It may be, however, that they owe their content of sulphur to the Black Shale, for a stratum which has all the characteristics of the shale, with its kidneys of iron pyrites, makes its appearance at the base of the mountain, a few miles north of the Springs.

In ascending the hill south of the Springs, there is first a gentle slope of several hundred yards over ground covered with fragments of a hard slaty sandstone, almost quartz schist, of grayish and white color. Then begins a sharp ascent of about forty-five degrees over fragments of the same rock, to the summit, about 300 feet above the Springs.

The summit of the mountain is composed of heavy-bedded sandstones, almost quartzite, striking north-east, and dipping south-east, at an angle of about fifteen degrees. The sandstone, as is usual with massive rocks, is intersected by joints, one section of which has the direction of the strike, and being at right angles to the bedding planes, forms the bold cliffs which overlook the valley of the Springs.

In crossing to the south side of this mountain through a gap or low place east of the Springs, after passing sandstones as above described in the lower part, we find sandy, half-metamorphosed slates above, on the southern slope of the mountain. From these slates, a few miles towards the north-east, rises a chalybeate spring which is much visited. Succeeding the slates towards the south, are strata of the Quebec Dolomite, and after crossing a narrow valley of it the Acadian slates are reached, with the belt of crystalline marble at the foot, as is the case all along the line of junction of the two formations towards the north-east. At Looney's Mill, on the opposite side of the mountain from the Springs, and at its base, the slates (semi-metamorphic) of the upper part of the mountain are exposed in considerable thickness.

Prof. Tuomey, in speaking of this locality, considers the mountain and its slates to be Sub-Silurian. Following him, I gave the same classification in my Report of 1874.

More extended observations, however, and the great similarity between these sandstones and slates, and those of the Kahatchee Hills, incline me to the belief that the mountain

is composed chiefly of Potsdam Sandstone, here very dense and compact, whilst the semi-metamorphic slates on the flanks are changed Calciferous or Knox Sandstone or Quebec Shales. The absence of all fossils, however, will cause some doubt to rest upon this matter, since even partially metamorphosed rocks are not always easily referred to their unaltered prototypes.

It remains now only to speak of the tract of country lying north of the Kahatchee Hills, and between the Pope Mountain and the East and West Range, as we have designated it. The greater part of this area as far as Alpine—perhaps the whole of it—is occupied by strata of Quebec Dolomite, sometimes with cherty soils supporting a growth of pines, sometimes more calcareous, and then forming good farming lands. Limonite is of frequent occurrence. At Mr. John Oden's residence, S. 13; T. 21, R. 3, east, there is quite an extensive bank of it, partly cherty, but chiefly of good quality so far as the superficial appearance goes. This is very near the line of the Savannah and Memphis Rail Road, and I doubt not will one day be utilized.

Not far from Mr. Crumpler's house, in S. 5, T. 21, R. 3, E., there is an extensive outcrop of limestone, the property of Mr. John Oden. It is a blue argillaceous banded limestone chiefly, but part of it is much purer. It strikes N. 10 deg. W., and dips about 85 deg. NE. The strike is approximately parallel with that of a ridge of Potsdam Sandstone in the immediate vicinity, but the dip is just the reverse of the dip of the strata of the mountain. These limestones have a good deal the appearance of some of the strata of chazy limestone seen in Shelby and Bibb.

Another quarry in S. 32, T. 20, R. 3, east, shows a similar series of rocks, with some bands of black velvety hornstone.

Lime has been burned from the stone of these quarries, and where properly selected a good article can be obtained. These localities are also near the rail road line mentioned.

CALHOUN COUNTY.

Topography.

The portion of this county examined during the past season embraces only its southern part, below Jacksonville; a small part east of the S., R. & D. R. R., from Oxford to Davistown and northward to White Plains; and west of the rail road, a portion of the county from ten to fifteen miles from the Coosa river. It will thus be seen, that the present report is only a partial one, whilst it embraces probably most of the geological formations found within the county.

The drainage of Calhoun county is all into the Coosa river, but in two directions; the one and principal direction being southward and westward, the former through a part of Talladega county; whilst the other is northward, through part of Cherokee county.

In order to present these two systems of drainage clearly before the reader, it will be necessary to refer to what has been said above in the geology of Talladega, and also to anticipate a little of what is to follow.

It will be remembered that the Potsdam chain, west of Talladega town, was said to die out towards the north-east before reaching Choccolocco creek. The chain is resumed again a few miles north-east of Choccolocco, and runs then without serious interruption northward, and north-eastward into Cherokee. The break in this chain in the southern part of the county determines the direction of the principal system of drainage for the Choccolocco, rising up in the north-east corner of the county at the foot of the quartzite ridge, which marks the eastern limit of Acadian slates, soon emerges from these into the Quebec Dolomite, and flows south-westward in this formation between the Potsdam Sandstone mountain on the west, and the hills of Acadian slates on the east, to

very near the southern boundary of the county, there turns almost westward, or a little south of west, and flows into the Coosa through the gap caused by the interruption in the Potsdam Chain.

As it turns abruptly westward it receives several tributaries from the south from the hills of Acadian slates, in Cleburne and Talladega counties. The largest of these tributaries are Hatchessofka, Wolfscull, Salt creek, and Cheahaw. It is seen, therefore, that the northern part of Talladega is drained off northward through this gap, whilst the middle and southern portions are drained through the other gap, which is found between Alpine and Childersburg.

The creeks which flow westward are shed by the Potsdam Chain, and the latter having more a south-westerly than a westerly course.

Nance's creek, a branch of Terrapin, rises also in the north-eastern part of the county, between the Potsdam Chain and the Acadian slates, thus almost overlapping with Choccolocco, flows, unlike Choccolocco, northward around the upper end of the Potsdam Chain, into the Coosa.

It can not fail to strike the most superficial observer, that the mountains of Potsdam Sandstone in this county and Talladega, have been all-important in determining the direction of the principal streams, and if, as there is good reason to suppose, the quartzite ridge, so often alluded to as forming the eastern boundary of the Acadian slates, be also Potsdam Sandstone metamorphosed, the importance of this formation as a watershed is all the more apparent, for only Talladega creek cuts through it, in Alabama, at least south of Cherokee county.

From what I have said above concerning the drainage, the general topography of the county will be easily understood. The highest points are probably along the quartzite ridge which is the dividing line between Calhoun and Cleburne. West of this are subordinate hills of slates, and then a ridgy country of Quebec Dolomite. Succeeding this, towards the west, is the chain of Potsdam Sandstone, peaks of which rise abruptly 1225 feet or more above the level of the Dolomite.

Westward thence to the Coosa, is a broken country of Quebec Dolomite and its cherty ridges, with less important belts of other formations, which need not be here further particularized.

GEOLOGY.

The formations which have been identified in Calhoun are—

1. Acadian—slates and conglomerates.
2. Potsdam—sandstones and shales.
3. Calciferous Sandstone. (Knox Sandstone.)
4. Quebec Shale. (Knox Shale.)
5. Quebec Dolomite. (Knox Dolomite.)
6. Chazy.
7. Cincinnati Group.

1. Acadian.

The rocks of this group in Calhoun county have not been studied, except in crossing them from Davistown towards Ross' Ford on the Tallapoosa. There is very little to be added to what I have said of these rocks in Talladega, and in crossing them at this gap, the section exposed is far less complete and satisfactory than that on Talladega creek.

2. Potsdam.

The rocks of this formation are sandstones, coarse and fine grained, (the former sometimes passing into a conglomerate,) and sandy shales. The latter less abundant and characteristic than the sandstones.

The sandy rods, formed by filling in of the burrows of *Scolithus*, are abundant in every outcrop of the Potsdam sandstone visited in this county.

The mountains seen west of the S., R. & D. R. R., from the Alabama Furnace to Oxford, and east of the rail road from there beyond Jacksonville, are composed of this sandstone.

East of the main chain, several subordinate ridges and knobs of the same rock occur, which will be noticed below.

DETAILS.

From the Alabama Furnace in the northern part of Talla-

dega county, a tolerably high and isolated mountain may be seen towards the north and north-east. It begins about S's 20 and 29, T. 16, R. 7, E., and trends nearly due east to Oxford, where it ends abruptly.

A short distance from the end of this mountain, begins another of the same rock, and through the gap thus formed the rail road passes from the eastern and southern, to the northern and western side of the Potsdam chain.

The short mountain, about six miles long, first mentioned, has the local name of Coldwater mountain. Its highest peak about S. 28, T. 16, R. 7, E., is 1025 feet above the rail road at the Furnace. The eastern or southern flanks of the mountain show a narrow belt of reddish and choccolate colored shales of the Quebec Group, and probably Calciferous or Knox Sandstone would be identified upon closer examination.

The summit of the Coldwater Mountain is covered with huge masses of sandstone, many filled with *scolithus rods*, but otherwise the counterpart of what were seen on the tops of the peak at Alpine, and elsewhere on the southern prolongation of this chain. The strike nearly east and west, and dip south.

In several places on this mountain I noticed large accumulations of irregular concretionary masses of brownish chert.

On the southern face of the mountain about section 28, and near by, on the northern side, separated by a narrow comb or ridge of sandstone, are two immense funnel-shaped depressions in the sandstone, from two to three hundred feet deep, and several hundred yards across from rim to rim. The sides of these funels are almost precipitous, some parts being perpendicular cliffs formed by the broken faces of sandstone.

These funnels are not gapped on any side. In the southern one a stream of water is said to fall, and disappear through the crevices at the bottom; at any rate it does not cut through the rim in any place. The northern funnel has no running water in it, nor is there any accumulation of water at the bottom. I did not descend into either, on account of the lateness of the hour at the time of my visit, and the time necessary to descend and climb out. From the edge of the divid-

ing ridge where both of these depressions can be overlooked, their unbroken rims can plainly be seen. Upon the inner slopes are growing the large forest trees of the mountain.

At the western extremity of this mountain in the Quebec Dolomite, a large area covered with bold springs supplies a great volume of water for a short creek, the Coldwater, which flows into Choccolocco three miles from its source. The western extremity of the mountain widens out into several short spurs, and at the eastern end at Oxford, also, the mountain is not a single ridge, but divided. At the latter place the sandstone is literally filled with *scolithus rods*, and the little round spots which mark the cross sections of these rods on the bedding planes of the sandstone.

Just across the rail road at Oxford, nearly opposite the end of the Coldwater Mountain, begins the Ladiga or Choccolocco Mountain, as it is called, which continues on beyond Jacksonville. Except at the southern extremity, this is likewise not a single ridge, but rather an aggregation of ridges, the exact structure of which has not been fully made out. Between the prongs or fingers of mountain thus caused, are elevated coves, which, near Oxford, are the repositories of some of the best of the limonites which supply the Woodstock Furnace, and of which more will be said below at the proper place.

Snow's branch, a small stream which rises north of this Potsdam ridge, instead of flowing around the end of the ridge cuts through it just in the edge of the town of Oxford, and lays bare a very good section of the constituent rocks of the ridge. These are heavy-bedded solid sandstones chiefly, with some sandy shales on the south-eastern flank. One stratum of the sandstone is peculiar from the specks of hydrated ferric oxide, which give to it the mottled appearance of granite. On the south-eastern flanks the brownish sandy shales, though probably belonging to this formation, may belong to a higher group. Succeeding these, south-east, comes the Quebec Dolomite, which prevails, with few interruptions, to the hills of Acadian slates.

Where Snow's branch has cut through the last heavy bed of sandstone of the mountain towards the south-east, there

is a bed of brown iron ore in irregularly shaped lumps, which, when broken open, show an unchanged kernel of pyrite within, and every step of the progressive change from pyrite to limonite may be observed on a hand specimen. The lumps have all the irregularity, pitted surfaces, &c., of the limonite of the ore banks, and the *possibility* of a similar origin for some of the ore is thus beyond doubt.

The sandstone of the ridge, where cut by Snow's branch, dips south-east and strikes north-east, the direction of the ridge at that place. Further north-east, however, the mountain bends around, taking nearly a northern course, which it holds beyond Jacksonville.

Some six or eight miles north-east of Oxford, one of the high points of this mountain has an altitude above the railroad of 1,225 to 1,250 feet, and, as Oxford is 678 feet above tide-water, of 1,903 to 1,938 feet above the sea. (The elevation of Oxford is from the surveys of the Selma, Rome & Dalton Rail Road.)

In riding along the summit near this peak, I noticed the same alternations of compact sandstone and sandy shales, making higher and lower points, as has been described above on Crumpler's Peak in the Kahatchee Hills. A further point of resemblance between the two places may also be cited in the occurrence of a depression upon the summit here, in which water stands during most seasons of the year, the pond above Oxford being at least 1,100 feet above the rail road.

The complex structure of the mountain is shown by the spurs which curve out from the main direction of the chain and enclose huge mountain amphitheatres, with almost precipitous sides, which are covered with loose fragments of the sandstone. The difficulty of descending the steep sides of one of these mountains enclosing a cove, is very great, at some points insurmountable. One of the amphitheatres spoken of holds parts of sections 25, 26, 35 and 36, township 15, range 8, east.

Near Mr. Thomas P. Renfro's, section 26, township 15, range 8, east, there is exposed a great thickness of tough fine

grained black slates. They have the appearance in the quarry of good roofing slates; but I do not know that any have been excavated which are fissile enough for that purpose. These may be Acadian slates brought up in the up-heaval of the Potsdam Sandstone, and such seems most probably their true age, though their exact relations were not completely traced out. From the cove in which they occur one of the tributaries of Cane creek takes its rise, and a short distance below the slates, down the branch, very good and pure limestone is found, (apparently Chazy, though possibly Quebec,) no fossils were observed.

Crossing the mountain again from White Plains over to Jacksonville, the same rocks are observed. The mountain is there several miles wide, and not a single ridge. Beyond Jacksonville, I have not as yet made any observations.

I have yet to speak of occurrences of the rocks of this age between the main ridge and the Acadian hills. In going from Oxford north-east to Davistown, just before crossing Choccolocco at Morris' mill, one of these ridges is passed, and beyond it at the mill, outcrops of Calciferous or Knox Sandstone and accompanying shales, succeeded by Quebec Dolomite. Then another Potsdam ridge, and another, three in all, between Oxford and Davistown, section 11, township 16, range 9, east.

Going north from Davistown to White Plains, the same succession may be observed, three being passed between Davistown and Capt. W. R. Hanna's residence. Then two miles north of Hanna's another, and at Mr. Charles Martin's still another, which at that place is cut by Choccolocco creek. These little ridges are not so much continuous ridges as lines of rounded knobs with lower places between. On the south-east flank of each was noticed a belt of Quebec Shales passing upwards into the Dolomite, which with its cherty ridges and accumulations of limonite, forms most of the Choccolocco valley. The strike of the Potsdam ridges appeared to be more towards the north-east than that of the main ridge, which is nearly north and south. I give these few notes simply as matters of interest, for the only observations I have

been able to make, were during a hurried drive through the region in question. A more detailed survey of this part of the county will be made, I trust, at no very distant day.

3. Calciferous or Knox Sandstone.

Mention has been made of occurrences of the rocks of this Group, incidentally in the preceding section. At Morris' mill it is seen in a small ridge where it has been quarried to some extent to furnish material for building the dam and the pillars at the mill. The usual characteristics of the rock are seen there. This sandstone may reasonably be looked for on the south-eastern faces of the little ridges of Potsdam Sandstone, which were mentioned near the close of the preceding section.

Three miles west of Jacksonville may be seen a sharp-crested ridge. This is composed of Calciferous Sandstone, striking north-east and south-west and dipping south-east, and on the eastern flank is a belt of Quebec or Knox Shales.

The sandstones are of the usual agreeable colors, and the bedding planes are smooth, and marked with fucoidal impressions and ripple marks. How far this ridge continues north and south is not yet accurately made out.

I have information of the occurrence of rocks of this age in other parts of the county further west, viz., the continuation of the ridge which makes the Jackson shoals on Choccolocco, and on the eastern limit of the Coosa coal fields, but these two belts I have not personally observed.

Of useful materials from this horizon in Calhoun, I have none to record, except that the sandstones are occasionally used for building purposes.

4. Quebec or Knox Shale.

A narrow belt of these shales is commonly found on the eastern flanks of the Potsdam Sandstone ridges, and ridges of Calciferous Sandstone. I have noticed them on the southern face of Coldwater mountain, and also in the eastern Dolomite belt between the Potsdam chain and the Acadian slates,

wherever the subordinate ridges of Potsdam Sandstone appear.

Again, west of Jacksonville, a very plainly marked belt of Quebec Shales is crossed just before reaching the ridge of Calciferous Sandstone, to which allusion was made in the section above.

The formation contains no materials of economic value that I am aware of in this county.

5. Quebec or Knox Dolomite.

As was the case in Talladega county, so here, the greater part of Calhoun county is Quebec Dolomite. It is found in two areas separated by the chain of Potsdam Sandstone. The western belt, I have examined only along one route. Jacksonville is situated upon this formation near where the Potsdam Sandstone has been brought up by faulting, to its level. Near Jacksonville the formation is rich in ore deposits, but these remain yet to be examined. Westward from that town one passes from the Dolomite in to the Knox Shale, and Knox Sandstone some three miles distant, and crossing the line of a fault, comes into a belt of Cincinnati Shales, and marble, and thence into the Dolomite once more, which prevails as far as I have gone in that direction, about six or eight miles.

In section 36, township 13, range 7, east, a magnificent spring bursts out from the side of a hill where an embankment has been made in times past for some rail road. In section 1, township 14, range 7, east, on the property of Mr. Schank, there is a strong sulphur spring near the banks of a little stream. The spring appears to come up from strata of Quebec Dolomite, which make the surrounding country. In the vicinity is the old Draper lead mine, where galena has been found impregnating a limestone. Notwithstanding the fact that this occurrence of lead has been known for years, a paying vein of the ore has not yet been brought to light. This is near the upper part of the Dolomite where it passes into the Chazy or some higher group, and I am not sure that

the lead-bearing limestone belongs to this formation, though such is most probably the case.

From Alexandria south-westward, towards Talladega, the way is chiefly over the Dolomite. At Alexandria there are strong indications of iron in the color of the soil, and small fragments of limonite to be seen by the roadside, and two miles from the town is a great accumulation of the ore.

On Cane creek, not far west of Martin's cross roads, (section 7, township 15, range 7, east,) the ore banks have been worked to furnish material for a Catalan Forge in the olden time. From one of the old pits formed by the removal of the ore, rises a Chalybeate spring.

Six miles west of the Cross Roads, on Cane creek, there is also a sulphur spring, which I have not yet visited.

At Morris' mills, on Cane creek, a mile or two south of the Cross Roads, there is exposed a very good section of cherty dolomite principally, striking north-east and south-west, and dipping south-east.

From this point south-westward for ten miles, to near Mr. Dill's, section 16, township 16, range 6, east, just in the edge of Talladega county, there is an unbroken stretch of barren piney woods country, with hills of chert, in all respects the counterpart of the country crossed in going from Talladega to Collins' Ferry. A mile from Mr. Dill's the strongly ferruginous clay soil sets in once more, the country is more fertile, and the limonite pebbles become more and more abundant.

At the western extremity of the Cold Water mountain, boils up a wonderful spring, or series of springs, which pours such a volume of clear water into the Choccolocco by the short, three miles long, Cold Water creek.

In the vicinity of Oxford, this western belt of Dolomite seems particularly rich in ore, and all the little strips of Dolomite, which run up between the spurs of the Potsdam Sandstone, above Anniston, are charged with this ore.

Of the details of these ore banks, more will be found below in an appropriate section.

On the eastern side of the mountain the Dolomite, with its cherty ridges and beds of limonite, covers the country to the

semi-metamorphic slate hills of the Acadian Group. Interruptions in the continuity of this Dolomite belt, by ridges of Potsdam Sandstones, with their linings of Knox Sandstone, and Quebec Shales, have already been noticed.

All the spaces between these ridges are occupied by the Dolomite, and it is not an unusual sight to find large accumulations of brown iron ore on the flanks of a ridge of Potsdam Sandstone.

Fine springs abound in this, as in all other areas of the Dolomite. A few miles east of Oxford the Boiling Spring has long been known.

At Capt. W. R. Hanna's is another noted spring, section 26, township 15, range 9, east.

The Dolomite of this belt has been used without much satisfaction in the Woodstock furnace as a flux. A quarry near Dr. Snows, section 20, township 16, range 8, east, has been worked for that purpose. Analyses of this rock and of one near the Boiling Spring, given in Prof. Tuomey's Second Report, show that these are true Dolomites, or magnesian carbonates of lime, with, however, from ten to twelve per cent of silica. Strata pure enough for lime burning occur in many places.

Useful Minerals, &c.

The ores of iron occurring with the Dolomite make this the most important formation of the State from an economical point of view.

Of ore banks I can mention only a few of those which have been utilized, or those whose great extent deserve some particular notice. Allusion was made above to the ore banks on Cane creek, not far from the Coosa, which supplied a Catalan forge. One of the longest known, and perhaps most extensive bank, or series of banks, in Calhoun is in the vicinity of Oxford. This flourishing town is partly in section 20, and partly in section 30, of township 16, range 8, east, and is in the gap between two ridges of Potsdam Sandstone. The low place between these ridges is occupied by the Quebec Dolomite, which, every where in the vicinity of Oxford, is highly ferruginous.

On the north side of the Oxford end of Coldwater Mountain, ore banks of considerable extent are worked at present by Dr. Snow, and the ore sent to the Woodstock Furnace. Between Oxford and the furnace, in the little strips of low land running up between the spurs of Potsdam Sandstone, are everywhere banks of ore, generally the property of individuals. Many of these localities were particularly investigated by Prof. Tuomey, and several analyses of these were published in his second report. I have as yet no new analyses of ores from these places to add.

In S. 7, T. 16, R. 8, E., the Woodstock Furnace is situated, about 300 hundred yards north of the old Oxford Furnace, which was destroyed during the war. The fields about the furnace, east to the foot of the mountain, have been pretty well worked over in excavating ore.

North-east of the furnace, a few miles distant, is a cove in the Potsdam Sandstone, Rocky Hollow, whence comes a large part of the ore, and more particularly the manganiferous ores which have of late been worked up in the furnace. In S. 33, T. 15, R. 8, east, is one of the banks containing the manganese ore. This ore is partly a black and brittle ore of iron, with a large percentage of manganese, partly a soft black earthy mass which rubs off on the fingers somewhat like graphite, and partly a fibrous limonite, sometimes pure, sometimes manganiferous.

As has been intimated, the company has recently made considerable quantities of *spiegeleisen*, and I understand that arrangements have been made for the production of this metal for the market.

Near this section, 33, is another bank, with ordinary limonite. There is, however, scarcely a little cove between the spurs of the mountain which has not furnished its quota of ore to Woodstock, or to the old Oxford Furnace.

Over the mountain from Woodstock, on the south-east side, there is another very extensive outcrop of limonite near Mr. M. Garrett's residence, S. 11, T. 16, R. 8, E.

Still further east, near the hills of Acadian slates, are other great deposits of limonite. In the lower tier of sections of

township 15, and the upper tier of township 16, range 9, east, these ore banks are found in close proximity to the detached ridges of Potsdam Sandstone, to which allusion has been made above. Part of this ore is siliceous, and probably unfit for smelting, but the greater part is of excellent appearance. These localities are north and north-east of Davistown, and within two miles of that town.

As was noticed in Talladega county, so here, the larger deposits of limonite seem to lie nearer the Acadian hills.

Other details concerning the various occurrences of iron ore in Calhoun will be reserved for a future report.

Iron Industry of Calhoun County.

Woodstock Iron Works.

Post-office, Anniston, Calhoun county, Ala.; Selma, Rome and Dalton Rail Road. A. L. Tyler, President; Sam'l Noble, Secretary and Treasurer.

The furnace was put in blast April 13, 1873. One furnace 43 feet high, 12 feet bosh; closed top. Capacity, 500 tons per month; all pig metal for car wheel and foundry purposes. Blast, hot and cold; can change on cold blast in a few minutes. Blowing cylinder 72 inches in diameter, 4 feet stroke. Engine, 30 inches cylinder, 4 feet stroke. Gases are usd for heating the boilers.

Ore used, brown hematite; fuel, charcoal. Ores within $\frac{1}{4}$ mile of the furnace, unlimited in extent. Limestone, 4 miles distant; contains 99.24 Carbonate of Lime.

6 and 7. Chazy, Trenton, and Cincinnati Groups.

These will be considered together, for the reason that sufficient data have not yet been collected to separate them in the few localities where I have noticed their occurrence in the county.

Allusion has been made above to the occurrence of shales of the Cincinnati Group, in going westward from Jacksonville.

After passing the sharp crested ridge of Calciferous Sandstone three miles west of Jacksonville, we come into a belt of yellowish calcareous shales, with which are associated several beds of highly fossillierous crystalline limestone or marble. These shales and marbles are the counterparts of the shales and limestones of the Cincinnati Group, as exposed on the opposite side of the river from Knoxville, Tenn. I have very little doubt that they belong to the same group, though no recognizable fossils could be detached from the limestones. The lower part of these beds probably pass through the Chazy into the Quebec Dolomite, which succeeds and makes a wide belt towards the west.

Although I detected no beds of undoubted Chazy limestone, they will probably be found upon closer examination. I give, therefore, merely these notes.

At Aderhold's Mill in the NE. ¼ of S. 19, T. 14, R. 8, east, under the bridge a fine section of the shales of this group is exposed, and with them is associated a sandy ferruginous calcareous rock, similar to Safford's Iron Limestone.

From this place, south-west to Alexandria, the road lies wholly over these shales. At the latter town, or very near it, a belt of dolomite is entered, as has been indicated above.

Metamorphic Region.

Wood's Copper Mine.

With a view to laying before my readers an account of the operations at this mine, since the publication of my last report, a short trip was made to the locality during the past summer.

Mr. Wood has erected one calciner, with a capacity of 6,000 lbs. of ore in 24 hours; one reverberatory, with a capacity of 1,200 lbs. of calcined ore in 24 hours. These two furnaces are calculated only to make a matte of 35 per cent. There is also a crushing mill of four stamps, with an engine of 30 horse power.

It is in contemplation soon to put up two blast furnaces and a refiner, and to produce ingot copper on the spot.

The amount of ore now lying in piles about the mouths of the shafts, and of the refuse from the ores shipped last year, is estimated to be about 800 tons. All this will do for smelting, and will probably average 8 to 10 per cent.

Up to date, (October 15, 1875,) Mr. Wood has raised and shipped about 1,500 tons of ore, averaging 15 per cent of copper, for which he has received $3.75 per unit of the per centage.

All the wild rumors about the large amounts of silver contained in the ores, are reduced to the simple fact that with the ores, are found occasionally, masses of rock impregnated to some extent with sphalerite or zinc blende, which shows a trace of lead and silver when carefully tested. The amount of sphalerite is extremely small, and the silver or lead in it a minimum.

As was stated in my previous report, the vein is a bedded lode, with the richer black sulphuretted ores, (which are commonly called black oxide,) lying between the "gossan" above, and the "mundic" or solid pyrites below. As yet, only about 150 yards of the vein have been mined, and only the richer ores have been raised, except where the yellow sulphuret has been mined for smelting, within the past few months. There has been no exploration of the vein by which either the thickness of the mass of cupriferous pyrites under the black ore or its depth is ascertained. It has been cut to a depth of twenty feet and a width of ten feet through the solid mass, without reaching the limit of the vein in any direction, so that the probable amount of these pyrites, which averages about 9 per cent of copper, is very large. As far as the vein has been worked the higher grade ores have been taken out, but the great waste thus incurred has induced Mr. Wood to provide for the working up of all his material at the mine.

Besides the cupriferous massive pyrites, a light colored talcoid slate, smooth and soapy to the touch, and impregnated with the black sulphide, is used (mixed with the yellow sulphide,) in smelting, but it fuses with difficulty. The average

per cent of copper in this is about 8, but frequently streaks of black sulphide, several inches thick, are found in it.

To Mr. Wood and to Capt. Adolf Thies, I am indebted for much of the information given above, especially as regards the quantity of ore raised, and the figures concerning the furnaces.

At my request, Prof. W. C. Stubbs, of the Agricultural and Mechanical College, has made several analyses of the best specimens of the ore from Wood's Mine.

It will be seen that they are all sulphuretted ores, though thin superficial coatings of the carbonate, &c., give to them a variegated appearance.

No. 1, marked *Azurite*, from the numerous crystals of that mineral, seen upon the specimen. With these were also crystals of *Chalcopyrite*, patches of *Malachite*, &c. Brittle and porous, and easily crushed.

A partial analysis showed:

Copper (metallic)	10.62
Iron	23.10
Sulphur	29.20
Insoluble matter	4.00

No. 2, marked Copper Ore (*Chalcopyrite.*) This sample is principally the black ore, with crystals of chalcopyrite disseminated through it, giving it lines of easy fracture. Harder than No. 1, and more compact.

Metallic copper	34.95
Iron	Not determined.
Sulphur	14.90
Insoluble matter	7.30

No. 3, marked Copper Ore, (*Malachite.*) This sample is very porous and consists chiefly of chalcopyrite, with deposits of the green carbonate on the edges and portions of surface:

Metallic copper	19.24
Iron	25.20
Sulphur	23.10
Insoluble matter	16.60

No. 4, marked Copper Ore, (Black Ore.) Sample porous and very brittle, but like the others, mixed with the other compounds of copper.

Metallic copper	43.04
Iron.	15.47
Sulphur	11.40
Insoluble matter	7.40

No. 5. Marked Cuprite.

An impure porous specimen, containing much iron.

Metallic Copper	45.24
Iron	31.29
Sulphur, not determined	0.00
Insoluble Matter	4.20

These are generally picked specimens, the mass of the ore averaging, according to recent assays by Capt. Thies, about 10 per cent copper. Upon the composition and mode of origin of these ores, see further, the Report of Progress for 1874, and the remarks of Prof. Stubbs, in the Chemical Report below.

North and north-east of Wood's Mine very numerous excavations have been made by various parties in the search for copper. One mile from Wood's is the shaft sunk by Ex-Gov. W. H. Smith, from which very fair specimens of the yellow sulphide have been extracted. Analysis of a specimen from this mine was given in my report for last year. Since that time a new shaft has been sunk, machinery set up, and preparations made for systematic working. We may reasonably expect that paying ore will soon be found in some of the localities where it is so diligently sought.

Within two or three miles of Gov. Smith's shaft, many trial shafts have been put down. Some of these I was able to visit, and whilst in none has a paying ore of copper been found, in several, chemical test shows the presence of some copper. Most of these openings are in township 17 and Range 11, E., and in sections 7, 17, 18, 19, 24, and 25. At Mr. M. J. White's,

at the mine of Messrs. Parr & Seymour, and of Mr. Driskell, the rocks excavated show a reaction for copper. The same is probably the case at the other localities given, but I can not speak of these from personal observation.

The history of most of these undertakings seems to be substantially this: A company with limited means, or an individual, sinks an expensive shaft through the hard rocks, down to water; by this time the means are so nearly exhausted that a suitable pump for draining the mine can not be purchased, and so the enterprise is abandoned, to be renewed at some other locality with a similar result. The number of shafts in this vicinity, sunk to the water, is truly wonderful.

If a tithe of the money spent upon such useless shafting had been employed in the purchase of a diamond drill, by which the supposed copper veins could have been thoroughly tested before the heavy expense of shafting had been commenced, many sore disappointments and heavy losses would have been spared.

As in Prof. Tuomey's time, so now, the "practical miners from Ducktown" seem to be the bane of the country, often leading men to embark their fortunes in ruinous copper-mining enterprises, in localities where there is geologically not the slightest reason for expecting to find a vein of copper ore.

Under such guidance, I have seen men digging for copper in non-metamorphosed Knox Dolomite, a bed of limonite serving the purposes of the "gossan."

COOSA COUNTY.

In the vicinity of Goodwater Station on the Savannah & Memphis R. R., there are several localities of considerable interest. A good deal of work has been done there in search of copper, and whilst no paying ore has been extracted, there is a very distinct trace of copper to be found in some of the rocks.

In the village, a pit has been sunk some 28 or 30 feet deep, in a gray arenaceous schist with scales of graphite. This

rock was mentioned in last year's report, as appearing near Mt. Olive in Coosa county, and also at several localities north-eastward in Clay county, between Mr. Weathers' and Candutchkee, and elsewhere.

The country rock near the station is syenitic gneiss, which in some places is more nearly a hornblendic rock, with a considerable admixture of talc, making what is known as Soapstone, at Mr. Nicholson's, and at one or two cuts above Goodwater. This rock cuts very easily, is quite massive, and resembles the soapstone of Tallapoosa county, except that it is tougher and rather more gritty; still, it is an excellent rock for many purposes.

In S. 3, T. 24, R. 20, east, an excavation for copper has been made by Ex-Gov. W. H. Smith & Co. on Mr. C. W. O'Neill's land. The rock here is a dark graphitic schist, with frequent scales of biotite, and also crystalline plates, from half an inch to an inch in diameter, of a green lamellar mineral, (probably talc.)

The same rock occurs frequently north-east of this in Clay county, at Mr. Weathers', at Mr. George Hobbs', &c. Pyrite is also of frequent occurrence, both in irregular masses and in sheets between the joints of the rock. Between some of the joints is found also a black soft pyritous mass, which resembles, in general, the black ore of copper, but it shows no trace of copper. Graphite is one of its constituents. As an efflorescence or incrustation on some parts of the walls of the shaft, there is a soluble salt of iron, probably the sulphate, which, when wet with water and placed upon the knife blade, coats it with copper.

The rock itself shows very little, if any trace of copper. The same strata are likewise exposed in the rail road cut near Hatchet creek.

In S. 10, T. 24, R. 20, east, in an old field there are found pretty large masses of *magnetite* with very evident crystalline faces, and strong polarity. All the fragments are considerably water worn, and are found scattered amongst water worn quartz pebbles, over a considerable area. In the rail road cut on Wild Cat creek, a dark colored stratum of rock attracts

the needle very strongly, and as this is only a few hundred yards from the locality just mentioned, the source of the magnetite may possibly be found in this rock.

The line of the Savannah and Memphis Road has been so chosen as to cross the mountains at a very low gap. The Rebecca mountain, which is represented on the maps as taking a southern course a short distance south-east of Syllacauga, really does take such a course, so far as its main heights are concerned, though it seems that the strata which compose it continue on in a south-west course into Chilton county. In other words, where the rail road crosses the mountain, there is a low gap, caused apparently by denudation only, as the strata have the normal strike. This low place in the mountains is by no means a level for the spurs of little hills of denudation, just out from the main heights on either side into the low valley, and the rail road has to cross all these, making it almost a continuous series of cuts and fillings from Goodwater to Syllacauga.

In these cuts, the strata exposed have undergone decomposition to that extent, that they are in very few places anything more than stratified clays with interbedded layers of quartz.

Within three or four miles of Goodwater, the rocks cut are much harder and less changed, but beyond, to Syllacauga, the case is as represented above. I have often spoken of a prominent ridge of Quartzite, which forms the highest crests of this mountain at the gap, this rock is considerably worn down, but stills forms one of the highest of the points crossed by the road. The water courses west of this ridge flow *via* Tallasseehatchee into the Coosa; east of the ridge they are all tributary to Hatchet creek.

The rocks along the plank road, which crosses some miles south of the rail road, are much firmer and less decomposed. The highest point, where the plank road crosses the quartzite ridge, is, however, not more than 300 feet by aneroid observations, above Syllacauga.

CHEMICAL REPORT.

As in my last report, so in this, I have thought it desirable to present in tables, for greater convenience, the various analyses which have been given in the body of the report above.

I have again to acknowledge my indebtedness to Prof. W. C. Stubbs, of the Agricultural and Mechanical College, for the kind assistance which he has given me in this department.

To Mr. J. Blodge Britton, of the Iron Master's Laboratory, I am also specially indebted for a number of analyses of iron ores which he has free of charge made for the survey.

Acknowledgment has been made above to the liberality of Mr. Walter Crafts, Superintendent of the Shelby Iron Works; Col. S. S. Glidden, of the Alabama Furnace, and of Mr. Jas. Thomas, of the Eureka Furnace, for their kindness in permitting analyses made for them, but not yet published, to appear in this report.

The analyses referred to have been made by competent and trustworthy chemists, and no apology is necessary for publishing them. To Mr. Crafts, especially, I owe a large number of analyses.

The coal analyses are chiefly from Mr. Rothwell, but due acknowledgment is made in each case.

Analyses of Copper Ores from Wood's Copper Mine, Cleburne County, Ala.

Since nearly all these ores consist chiefly of iron, copper, sulphur, and insoluble matter, a general method of analysis was adopted, by which these substances only, were determined. The specimens analyzed usually contained a small quantity of that compound of copper to which the name had been given in the labels of the survey. But no specimen was homogenous in structure, many compounds of copper being found in the same specimen. Hence we have sought only for the above named ingredients.

The method of analysis was substantially as follows: The finely pulverized mineral was dissolved in concentrated nitric acid, with the aid of gentle heat. The solution, diluted with water, was separated from the unoxidized sulphur, and the insoluble matter, which were then carefully weighed on a well-dried and weighed filter, then ignited, and the amount of insoluble matter determined; the undissolved sulphur being estimated by the difference.

From the filtered solution, that portion of the sulphur which had been converted into sulphuric acid, was precipitated by *baric chloride*, and estimated as *baric sulphate*. The copper was next precipitated by *hydrogen sulphide*, as *cupric sulphide*, and thrown rapidly upon the filter, then dried, and dissolved, together with the incinerated filter, in *aqua regia*, the sulphur, of pure yellow color, separating. The solution was next filtered, and the copper determined in the filtrate, as *cupric oxide*, by boiling with *potassic hydrate*, igniting and weighing.

Wm. C. Stubbs.

TABLE I. COPPER ORES FROM WOOD'S MINE.

NUMBER OF SAMPLE....	1.	2.	3.	4.	5.
Copper................	10.62	34.95	19.24	43.04	45.24
Iron....................	23.10	......	25.20	15.47	31.29
Sulphur................	29.20	14.90	23.10	11.40	.....
Insoluble Matter........	4.00	7.30	16.60	7.40	4.20

No. 1. Marked Azurite.
2. " Chalcopyrite.
3. " Malachite.
4. " Black Ore.
5. " Cuprite.

It is interesting to note that in those specimens showing the carbonates—*i. e.*, No. 1 and No. 3—the percentage of copper is small, whilst the black ore, (the great mass of the ore at first mined) No. 4, shows much more copper. No. 5 is simply a mass of black ore with a superficial coating of *cuprite;* whilst No. 2, Chalcopyrite, is also chiefly the black ore with Chalcopyrite crystals intermixed.

Chalcopyrite, or the yellow sulphide, as will be seen above in the geological report, is the mundic or solid ore of the vein. It averages some 10 per cent. copper. The black ore lying between this below, and the "gossan" above, is considered generally to be a decomposition product of the Chalcopyrite, in which, as may be seen in the table, the percentage of copper is increased.

The long exposure to the atmospheric agencies, necessary to produce the carbonates, appears to have the effect of reducing the percentage of copper, probably by leaching.

See, also, Report of Progress for 1874.

E. A. S.

TAALE II. IRON ORES.

LIMONITES, OR BROWN HEMATITES.

Numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Combined Water	10.49	7.41	12.44	12.72	8.54	10.49	11.19	11.27	11.98	9.25	3.80	......	11.86	11.52
Siliceous Matter	6.04	3.06	7.84	5.61	2.34	14.11	3.09	13.49	1.50	7.06	11.74	0.76	7.58	11.71
Sesquioxide of Iron	79.93	82.84	73.10	78.63	87.49	76.15	84.10	73.44	84.03	78.86	81.35	......	77.54	68.93
Alumina	1.43	0.35	1.47	1.36	0.27	2.65	0.27	1.03	0.20	2.37	1.59	......	2.07	3.59
Oxide of Manganese	0.92	0.95	3.36	0.11	0.12	0.41	Trace.	0.00	0.20	1.49	0.75	......	......	3.77
Lime	0.07	1.02	0.11	0.06	0.82	0.11	1.02	0.38	0.24	0.58	0.57	......	0.07	0.10
Magnesia	Trace.	0.19	0.12	0.10	0.33	0.07	0.08	0.08	Trace.	Trace.	0.12	......	0.03	0.05
Phosphoric Acid	1.01	0.55	1.35	1.30	Trace.	0.80	0.20	0.33	1.22	0.37	0.11	......	0.29	0.13
Sulphur	0.00	0.45	0.00	0.00	0.48	0.00	0.46	0.28	0.03	0.14	0.16	......	0.00	0.00
Undetermined, and Loss	.11	3.18	0.21	0.11	......	0.21	......	......	0.60	......	......	......	0.56	0.20
Total	100.00	100.00	100.00	100.00	100.39	100.00	100.41	100.30	100.00	100.12	100.19	......	100.00	100.00
Metallic Iron	56.10	57.91	51.96	55.05	61.27	50.07	58.89	51.43	58.82	55.20	56.19	56.74	54.28	48.25
Phosphorus	0.45	0.24	0.58	0.57	......	0.35	0.09	0.14	0.49	0.16	0.05	1.52	0.13	0.06

No. 1. Limonite from Bank No. 1, Ashby Iron Company's land, Bibb county. Analyzed by J. B. Britton. *Average sample.*

No. 2. Compact, liver brown, variety of ore, Ashby Iron Company's land, Bibb county. Analyzed by E. A. Smith.

No. 3. Limonite from Bank No. 2, Ashby Iron Company's land, Bibb county. *Average sample.* Analyzed by J. B. Britton.

No. 4. Limonite from Bank No. 3, Ashby Iron Company's land, Bibb county. *Average sample.* Analyzed by J. B. Britton.

No. 5. Pipe ore, from Ashby Iron Company's land, Bibb county. Analyzed by E. A. Smith.

No. 6. Limonite from Dr. Starr's, Bibb county. *Average sample.* Analyzed by J. B. Britton.

No. 7. Radiately fibrous limonite; outer surface smooth, mamelonated, with reddish color; interior rough, more or less porous and ochreous, Shelby county, six or eight miles north-east of Montevallo. Analyzed by E. A. Smith.

No. 8. Compact limonite, breaking with smooth conchoidal fracture, moderately brittle. Color of ore, light liver-brown; of powder, yellow; Shelby county, six or eight miles north-east of Montevallo. Analyzed by E. A. Smith.

No. 9. Limonite; Shelby county, five miles north-east of Helena. Analyzed by E. A. Smith.

No. 10. Limonite, from the Banks of the Shelby Iron Company. Analyzed by Prof. C. F. Chandler.

No. 11. Roasted ore, from Banks of the Shelby Iron Company. Analyzed by Prof. C. F. Chandler.

No. 12. Black irou ore, from Alpine mountain, Talladega county. Analyzed by J. B. Britton.

No. 13. Average sample of ore from the Seay Bank, Talladega county. Analyzed by J. B. Britton.

No. 14. Average sample of ore from the Irona Bank, Talladega county. Analyzed by Mr. J. B. Britton.

TABLE III. IRON ORES.

RED HEMATITES.

NUMBER.	1	2
Metallic Iron	49.08	44.61
Silica, &c	23.45	29.06
Sulphur	0.11	0.00
Phosphorus	0.34	0.30
Alumina, Lime, Magnesia, &c	5.58	3.66

No. 1. Red Hematite ore from the mountain near Columbiana. Analyzed by Dr. C. F. Chandler.

No. 2. Red Hematite, also from the mountain near Columbiana. Analyzed by Mr. J. B. Britton.

Forged Iron, made from ore from the Irona Bank, Talladega County. Analyzed by J. B. Britton.

TABLE IV.

Metallic Iron	99 020
Carbon	0.198
Silicon	0.265
Sulphur	0.000
Phosphorus	0.122
Manganese	0.064
Undetermined and loss	0.331
Total	100.00

Furnace Scale, from the Stack of the Alabama Furnace Talladega County. Analyzed by J. B. Britton.

TABLE V.

Silica	1.46
Iron and Alumina	3.62
Zinc Oxide, Cadmium Oxide,	91.70
Graphite and undetermined	3.22
Total	100.00

TABLE VI. LIMESTONES.

NUMBERS	1	2	3	4	5	6	7	8	9	10	11
Carbonate of Lime	99.11	99.16	97.52	93.77	98.91	67.55	95.40	89.03	55.35	61.86	96.70
Carbonate of Magnesia	0.75	0.75	1.27	2.48	0.58	24.91	0.94	3.91	34.58	33.55	......
Iron and Alumina	0.13	Trace.	0.35	1.01	0.63	3.58	0.68	1.08	1.48	1.09	1.40
Siliceous Matter	0.39	0.15	0.78	2.09	1.08	3.46	2.25	4.88	7.75	2.86	2.50
Sulphur	0.00	0 00	0.00	0.16	0.05	0.02	Trace.	0.13	......	......	......
Phosphorus	0.00	0.00	Trace.	0.00	0.00	0.03	Trace.	0.00	......	......	......
Water, and Loss	......	......	0.08	0.36	0.00	0.45	0.73	0.84	0.84	0.64	......
Total	100.38	100.06	100.00	100.00	101.30	100.00	100.00	100.00	100.00	100 00	100.60

No. 1. Compact drab-colored limestone, showing occasional crystalline faces; breaking with splintery fracture. Shelby county, J. M. Reynolds' Quarry. Analyzed by E. A. Smith.
No. 2. Very fine grained to compact limestone, from same locality. Analyzed by E. A. Smith.
No. 3. Limestone from Mr. Jones' S. 28, T. 21, R. 2, W., Shelby county. Analyzed by Dr. C. F. Chandler.
No. 4. Limestone from Quarry of the Shelby Iron Company. Analyzed by J. B. Britton.
No. 5. Limestone from same Quarry. Analyzed by J. B. Britton.
No. 6. Seam from same Quarry, light-colored, granular. Analyzed by J. B. Britton.
No. 7. Dark-colored, compact seam from same Quarry. Analyzed by J. B. Britton.
No. 8. Limestone from Quarry on Selma, Rome & Dalton R. R., near Columbiana, Shelby county. Analyzed by Dr. C. F. Chandler.
No. 9. Limestone from Alabama Furnace Quarry, Talladega county. Analyzed by J. B. Britton.
No. 10. Another limestone from same locality. Analyzed by J. B. Britton.
No. 11. Limestone from Shelby Iron Company's Quarry. Analyzed by Prof. Stubbs.

TABLE VII. COALS.

	NUMBERS.													
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Specific gravity	1.22	1.29	1.29	1.38	1.29	1.28	1.12	1.28	1.25	1.35	1.30	......	1.38	1.36
Moisture	1.66	1.58	1.91	1.93	2.05	2.13	2.54	1.78	2.14	2.13	1.34	0.30	0.50	0.12
Volatile Combustible Matter	33.28	32.60	32.65	32.84	33.47	30.86	29 44	30.60	31.92	27.03	28 96	31.36	28.24	26.11
Fixed Carbon	63.04	62.62	63.91	59.64	62.20	64.54	66.81	66.58	63.68	66.22	60.58	65.45	59.69	71.64
Ash	2.02	3.20	1.53	5.59	2.28	2.47	1.21	1.09	2.26	4.62	9.12	2.81	10.92	2.03
Total	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	......	......	......
Sulphur as Sulphate	.097	.223	.071	1.001	.118	.320	.073	.085	......	.114	.090	0.08	0.64	0.10
Sulphur as Sulphuret of Iron	.428	.727	.559	2.779	.523	1.160	.455	.479	......	.388	0.730			
Sulphur in Coke	......	......	......	......	......	......	.214	.223	......	......	0.210			

Sample No. 1. From Cahaba Vein—Davis' Mine.
" 2. " " " Holt's Mine.
" 3. " Black Shale Vein—McGinnis.
" 4. " Moyle "
" 5. " Little Pittsburgh Vein.
" 6. " Conglomerate Vein.
" 7. " Helena "
" 8. " Coke "
" 9. " Gholson "

Sample No. 10. From Montevallo Vein.
" 11. " Gould "
These were analyzed by R. P. Rothwell.
" 12. From Conglomerate or Beaver Dam Vein.
" 13. " Newcastle or Milner Vein.
Analyzed by Dr. Otto Werth.
" 14. " Black Creek Vein.
Analyzed by Dr. Wm. Gesner.

THE COTTON WORM.

BY A. R. GROTE, A. M.

The present paper is preliminary to a more extended history of the cotton worm (*aletia argillacea* of Hubner; *noctua xylina* of Say,*) an insect, with whose ravages at least, the cotton planter is familiar.

The cotton worm, in the form in which it eats the leaves of the cotton plant, is the worm-like stage of the growth of a small moth, belonging to a group of which there are already over 1,200 known North American species. The perfect insects belonging to this family are called popularly by the name of Violet-moths; with us, in the south, we apply to these and other smaller moths (although belonging to distinct natural families) the name "candle-flies," from their habit of swarming to light in houses. Technically the family to which the cotton worm belongs is called *Noctuæ*, or sometimes *Noctuidæ*.

The cotton worm in its earliest stage is a fertilized egg, the product of the union of the sexes of the moth. This egg is deposited by the female moth on the leaf of the cotton plant. Within this egg, which is so small as not to be readily perceived, the growth of the young "worm" rapidly proceeds, until in a few days it is sufficiently grown to eat its way out through the shell and commence a free existence as a "worm" or larva. If we now examine this larva, we find that the body is made up of successive rings. The first three of these rings or segments, behind the head, bear each a pair of horny jointed legs, six in all, armed with bristles and terminating in

*In the Missouri Reports, and elsewhere, the name *anomis xylina*, just suggested by myself in 1864, is commonly used. I have recognized later, that Hubner's name has priority.

a claw. If we compare the cotton worm at this stage, with the common rain or earth worm for instance, which we find in the ground, we see that it differs by possessing these jointed legs, although the bodies of the two animals are alike in being made up of successive rounded rings or segments. They belong in fact to two different types of structure; the cotton worm being an Arthropod or jointed-foot insect, and the rain worm belonging to the true footless worms or Vermes. Counting backwards from the head, we find that on the 6th, 7th, 8th, and 9th, segments of the body of the cotton worm, there are pairs of short, fleshy projections, which are not jointed, but are used by the cotton worm for progression. The pair on the 6th segment are not used, and there are projections of the skin on the 10th segment also, showing a distribution of these fleshy processes or false legs along the line of the hinder part of the body, without reference to their usefulness to the animal, and in an imperfect condition of development. The last segment of the body is provided with a pair of these fleshy false legs for grasping the leaf and maintaining the position of the animal while feeding. When we come to examine the anterior end or head of the cotton worm, we find it made up of a harder covering above and beneath pairs of jointed appendages, the most prominent of which are the cutting jaws or maxillæ, which perform the office of supplying food by tearing off the leaf of the cotton plant. These jointed appendages to the head, are similar in structure to the jointed feet of the animal, though they serve a different purpose in its economy. They are here head organs. So that we now see that there are three distinct regions of the body in the cotton worm, characterized by three different kinds of appendages. These different regions are technically called head, thorax and abdomen. In walking, owing to the disuse of certain of the abdominal or fleshy false legs, the cotton worm doubles the body between the thorax, which bears the true jointed legs, and the 7th abdominal segment. This position of the body gives it the name of a half-looper. As it grows, the yellowish-green cotton worm casts its skin from time to time, feeding all the while, and growing rapidly.

The segments of the body are seen to be ornamented with black dots, which, under the microscope, appear as warts, some of which give rise to hair. In some of the worms there is a distinct dorsal line visible, wanting in others. This stripe down the back gives the worms a peculiar appearance; it seems to be a variation, the color due to the massing of pigment cells in the skin, and not a reflection of the digestive system of the animal, which commences at the mouth and ends at the last segment, through the opening of which the leaf food of the animal is expelled in little pellets. This variation of the markings of the cotton worm is interesting, because it shows the worm to be undergoing some slow process of modification, and it may be that its present mode of life in the Southern States is producing some change in itself.

In Central Alabama, I have watched the growth of the worms on the cotton plant. The worm appears there in certain seasons, as early as the latter part of June. After feeding for a period of about fourteen days, the cotton worms commence preparations for shedding their skin to pass into the chrysalis stage of growth. For this they spin a few loose threads of silk on the plant itself, which they rarely forsake for that purpose. Within this light web the last larva skin is thrown off, and the brown chrysalis skin is exposed. In this state the worm passes from a week to ten days. During this time, although appearing quiet outwardly, and without exterior organs of locomotion, growth takes place within the shell of the chrysalis. At last it has progressed so far that it arrives at maturity. Through an opening of the head and thorax at the back of the chrysalis, the full grown and perfectly developed cotton fly or moth appears, its wings merely little pads at the sides. These are quickly expanded by a muscular action, and by a circulation in the veins of the wing, which ceases so soon as the wings are dried in the sun. The body is now seen to be covered with scales; the wings cover the body so much, that at first we cannot see that it is, after all, the same animal which we knew first as a larva. But the three portions of the body

may be seen. The head has two long jointed antennæ or feelers. The jointed maxillæ have become a spiral tongue. The thorax supports its six legs as before, while the fleshy or false legs of the abdomen have disappeared, as being of no further service to the animal. The insect is now mature, and in a condition to commence its work of propagating its young. Although the sexual organs are present in an undedeloped condition in the larva, this insect in that stage is incapable of reproduction. The sexes are separate, and a true copulation takes place before the eggs of the female moth are fertilized, and their growth can commence.

A series of observations in Southern and Central Alabama, has convinced me that the cotton worm is an imported insect, and not indigenous to the Southern States. I had previously published some observations on that point, and I submitted a summarized statement to the American Association for the advancement of science at Hartford, in August, 1874. The cultivation of the cotton plant, upon which this insect feeds is artificial. In our climate this plant has become an annual The first herald of the cotton worm I have found to be always the flight of the parent moths. These would come to light in houses, and in a few days thereafter I found the young worms on the plants. This, in Central Alabama, was in June or July, and previovsly I had always heard of the appearance of the worm to the southward. Before it, the cotton in my vicinity had shown no sign of worm, and had any existed in the country it must have showed itself during the preceding three months, while the young cotton plants were growing. In favorable seasons the broods were successive until frost, and the death of the cotton plant. Where food failed on one plantation the worms wandered to another, but not till then. The first brood in one locality is irregular, skipping some plantations, invading others. Again, I have noticed that, while there was yet leaf enough left, and the season yet warm, whole sections would be forsaken by the freshly disclosed moths. There is no doubt on my mind, that the cotton worm has a yearly migration northward, from the facts in the case. The cold weather finally kills the

moths, without their being able to provide for a further brood. I have noticed the moth in the Fall as far north as Canada and the great lakes and on the coast of Maine. Always arriving there late in the season, it must perish; there is no food for its progeny; it is too late for it to retrace its steps. On this head I have already been able to contradict the published statements of Prof. C. V. Riley, in the 2d and 6th Missouri Reports, which, however, were not based on personal experiment. The reasoning there given with regard to the habits of the cotton worm, was entered into without that talented observer having sufficient facts before him.

The migrations of animals are among the most important circumstances affecting the forms of life. Wallace and Wagner have already shown how the separation, in this way, of local races or varieties may have given rise to new species. There is first to be considered, the involuntary migrations of animals by being floated down rivers, or conveyed by the wind. As we study those which are provided with wings, their voluntary migrations are seen to play an important part in their life. Birds and insects share these characters in common. Flights of the storm butterfly (*Danaus Plexippus*,) have already been noticed crossing the great lakes in the Fall, and going southward as if to endeavour to hybernate in a warmer climate. This butterfly hybernates in Alabama. Flights of butterflies have been frequently observed in regions as remote as the English Channel, and the Amazon river. The cotton worm moth is strong-winged and has a lithe, smoothly scaled body, offering very little resistance to the wind. Although the wind may accelerate and assist its migrations, I regard them as voluntary, from the facts of its structure and the wide territory which it covers. The cause of the northward migration of the cotton-worm moth from more southern localities over the cotton belt, and as far north as Canada, cannot be suggested as yet, the data not being all known. One thing is clear, that the territory growing cotton, over which they pass, increases their numbers by providing them with food, and thus makes them an enemy of the cotton planter.

I have not had the opportunity of experimenting with any of the preventatives or remedies against the cotton worm, of which I have seen public notices. Those in which Paris Green enters the composition seem to have been most successful, from their cheapness and poisonous effect. Care in the use of such material cannot be too strongly recommended. The metallic basis of Paris Green stays in the soil, is washed into channels, or by infiltration may reach into springs. It cannot be got rid of by evaporation. It is a poison to all animals.

I have suggested that, in order to act intelligently against the cotton worm, concerted action by the planters is necessary, and that the artificial agent used to destroy the cotton worm be employed against the first brood as it appears in any given locality to prevent its spreading further. I finally suggest that there be a thorough collecting of all facts concerning the worm in different portions of the State, and that such data, revised by a competent scientist, be published by State authority. A collection of all the facts relating to the insect, and other diseases of the cotton plant comes clearly as a duty, which an intelligent State should perform, where its interests are so largely engaged in the matter as are those of the State of Alabama.

APPENDIX A.

To Col. Watrous, President of the Alabama Coal Mining Co.:

SIR—In reply to your note asking for information in relation to that portion of the Cahaba Coal Field in which the lands of the Alabama Mining Company are situated, I have great pleasure in sending you a brief report on the subject. This report is derived from my published reports, and from the results of an exploration made during a short vacation last summer; and although the subject will be more fully presented in my forthcoming report to the Legislature, yet as you deem it of importance to the interests of your enterprise, as it certainly is to those of the State, to make known as early and as widely as possible the extent and value of our mineral deposits, I most cheerfully give you such information as I possess on a subject in which, both from duty and inclination, I take so deep an interest,

I am, sir, very respectfully yours,

M. TUOMEY.

October, 1855.

REPORT.

Description of the Eastern side of the Cahaba Coal Field.

The Cahaba Coal Field was first opened near its southwestern extremity, above Pratt's Ferry, and on the right bank of the river. It was the intention of the company formed for the purpose of exploring the coal found here, to use the river as a means of transportation, but the well-known difficulties attending the navigation of all our streams above the falls, caused this enterprise to be abandoned; in the mean time the extension of the Ala. and Tenn. R. R. R. to Montevallo, soon directed attention to the eastern side of the field

as most likely to be first available, as the rail road would afford to the product of the mines an outlet always certain and reliable, and moderate in cost of transportation. It is in this portion of the coal field that the property of your company is situated.

It is an interesting fact that the Cahaba Coal Measures do not thin out gradually towards the edge of the field, but abut abruptly against the upturned Silurian rocks.

In the first examination of the Cahaba valley, west of the river, I pointed out the fact of the high inclination of the beds composing the coal measures. I was not then aware that a considerable portion of the field is composed of horizontal or slightly inclined beds, although on Turkey creek I had examined a single coal bed.

During a hasty exploration made last spring, I found that the beds immediately north of the anticlinal line marked on the accompanying map, are either almost level, or slightly inclined with a dip towards the north-east. A singular state of things is found to exist in the northern portion of the field. To understand this, it is only necessary to recur to the fact, that the Cahaba Coal Measures present in their structure immense flexures, or folds, and that the level beds are found on the summit of these curvatures, whilst the inclined beds constitute their sides.

But I must refer to the reports on the geology of the State for explanations of these phenomena. The lands of the company examined by me are two tracts, a northern and southern one, the latter containing 3,360 acres, and the former 1,440, making in all 4,800 acres of productive coal measures. The Alabama Coal Mining Company own other lands in the coal district which have not yet been worked, and the quality of coal on them is not known, though it is the opinion of those who know most about them that they are rich in coal.

Watrous Bed.—To the south of the level tract on the map will be seen the isolated quarter section, containing 160 acres. A seam of coal highly inclined, five (5) feet thick at the outcrop, is found here; it is known as the *Watrous Bed*, and is the most southerly coal exposed on the company's lands.

Pushmattahaw Beds.—The Little Mayberry creek flows over the edges of the strata, and as it passes through a gorge in the anticlinal ridge, it exposes the section Fig. A on the map, known as the *Pushmattahaw Beds*. The strike of the beds is nearly east and west, and the dip 85 deg. towards the south. In the distance of 300 yards five or six seams of coal occur, of which three at least are workable.

I propose at present to direct attention but to two of these, marked *a* and *b* on the map. As these sèams are opened, a fair opportunity was presented for their examination. The bed *a* consists of two seams of 12 and 18 inches of coal, separated by 8 inches fine clay, making 30 inches of coal. The bed *b* is 4 feet 6 inches thick, owing to the inversion of the strata here; the floor consists of sandstone marked with impressions of large coal plants, whilst the roof is composed of a thick bed of indurated under clay, filled with *Stigmaria*.

The distance between these seams is 114 yards, so that by driving a cross-cut between them, the coal may be raised economically from one shaft.

The Pushmattahaw Beds outcrop in the company's land for a distance of one mile and a half, or 2,640 yards. Supposing the coal to be worked to the moderate depth of 150 yards, the thickness of clear coal in the two adjoining beds being 2.33 yards, and the specific gravity of the coal 1.304, from these data we arrive at the fact that the Pushmattahaw beds contain 904,924 tons of available coal.

Level Beds.—A little higher on the stream the strata lose their great dip and become nearly horizontal. Indications of more than a single bed occur here, but the sides of the ravine and the bed of the branch are covered with loose masses of rock that hide everything,—so that nothing absolutely certain was determined here. At the source of the stream the principal outcrops of the level beds are found. The upper one of these is known as *Woods' Pit*. The dip head level here is north 47 deg, west, and the dip of the coal 1 in 9 towards the north-east; portions of the seam are full three feet thick, but it varies between this and two feet. Although the most extensively worked of any of the Cahaba beds, it has not yet

been explored to a distance greater than 60 yards from the outcrop. About a quarter of a mile south of this, another exposure of the same seam is found, which is known as the *Fancher Pit.* Here the strike is found north 15 degrees west, and the dip 1 in 6. It is from these beds that the principal part of the coal hitherto carried to market from the Cahaba coal fields, has been derived.

Still nearer the ridge, a drift has been commenced which shows a course nearly east and west, with scarcely any dip. These are doubtless all outcrops of the same bed, changing in strike and dip as it approaches the anticlinal ridge. Farther west towards Murphy's creek, coal is exposed on the corner of a quarter section of the company's lands.

This seam occurs within 60 yards of the vertical rocks, but has itself a distinct dip in the opposite direction; and about 50 yards north the whole series become horizontal. About one-half mile above the house of Mr. Davis, and very near the creek, another seam is exposed under an enormous bed of conglomerate. As the field has never been proved by boring, and the whole being one unbroken forest, it becomes very difficult, especially where the rocks are undulating or slightly inclined, to determine the number of beds superimposed upon each other, still I think it scarcely possible that the bed exposed here can be identical with those laid bare farther west, and I am quite certain that the latter one is not.

I have already mentioned that west of the outcrop of these seams, there occur beds of shale, including coal plants and other pretty certain evidence of the vicinity of coal. But as I intend to base no calculations upon data not absolutely certain, I shall take into account only two seams positively known to occur; the one at *Woods' Pit,* and that at Murphy's creek, which may be safely taken at an average of 30 inches each, or an aggregate of five feet clear coal.

The dip decreases rapidly towards the north and east; at *Brown's Pit* it is 1 in 12, and if we take this as a average, the coal will be reached one mile from the outcrop at *Woods' Pit,* at a depth of 150 yards. About two square miles of the tract occupied by the level beds are underlaid by coal, which gives

in round numbers 10,071,694 tons of coal. Adding this to the amount found for the Pushmattahaw Beds, and we will have—

	Tons.
Pushmattahaw Beds	904,924
Level Beds	10,071,694
Total	10,976,618
Deduct one-fourth for all sorts of wastage	2,744,154
Amount of available coal	8,232,464

in the lower or southern tract, and within the short distance of three miles of the Ala. and Tenn. R. R. R.

Tustinuggee Beds.—The northern tract is at a distance of about five miles from the nearest point of the Ala. and Tenn. R. R. R. Although this tract can scarcely be said to be explored at all, it is known to contain some exceedingly interesting seams of coal.

On a small stream which, like the Little Mayberry, lays bare the upturned edge of the strata, the section represented on the map at Fig. B. is found. In the short distance of 35 feet, more than three yards of coal may be seen at this fine locality. The first seam, at the northern end of the section, has seven feet of coal, and is separated from the next, which has 17 inches of coal, by a parting of shale eight inches thick. The third seam is one foot thick, and the fourth has two feet of clear coal.

Besides these, there are some other beds towards the west that are also found outcropping on this tract; one of these I measured and found it to contain four feet six inches of coal. All these beds are highly inclined, and dip towards the south. In the following estimate I only take into account the first two seams of the *Tustinuggee Beds*, making over eight feet of coal, and four feet of the other bed, in all four yards.

These beds occupy more than a mile in length at the outcrop, as they extend across the tract. I suppose, also, that the coal will ultimately be worked to the depth of 150 yards.

The amount of coal in this tract is equal to...	1,034,196	tons.
Deduct for waste one-fourth................	258,549	"
Available coal........................	775,647	"

The total quantity of coal known to exist in both tracts is, therefore, as follows:

Southern tract............................	8,232,464	tons.
Northern tract............................	775,647	"
Total on both tracts................	9,008,111	"

The cost of raising the coal at the pits, the cost of transportation, and other incidental expenses, being known, your Secretary can easily calculate the profits likely to accrue to your company from their investment.

The cost of transportation will be greatly reduced by the construction of your proposed rail road to connect the pits with the Ala. and Tenn. R. R. R. The surface, at least on the eastern side of the property, seems exceedingly favorable, judging from the profile constructed by the engineer who surveyed the route—the grades being greatly in favor of the way from the pits.

Quality of the Coal.—A sufficient quantity of coal has already been sent to the Mobile and Montgomery markets from your pits, to have its quality, both as *fuel* and for the manufacture of *gas*, fully tried. It may, however, be worth while to compare it with other coals of a similar character with which it may be likely to come into competition.

Dr. Mallet, who has charge of the chemical department of the survey, has analyzed two specimens, one from the *Pushmattahaw beds*, and the other from *Wood's pit*, with the following results:

Matter.	*Wood's Pit.*	*Pushmattahaw Beds.*
Volatile Combustible.....	35.51	36.68
Fixed Carbon............	57.42	57.23
Ashes...................	6.31	5.30
Moisture................	.76	.79
	100.00	100.00
Specific gravity..........	1.294	1.304

It appears from these, that your coal belongs to the variety called fat bituminous coal. Very few of the coals brought to the Atlantic cities can compare with this for the manufacture of *gas*. Of thirty-four specimens analyzed, from the various mines of Eastern Virginia, only three exceed, three are about equal, and the rest are much below it in the amount of volatile combustible matter.

Pre-eminent as are the Frostburg or Cumberland coals for the generation of *steam*, they stand far below the Cahaba coals for the production of *gas*. It is only in the western parts of Pennsylvania, Virginia, and Ohio, that beds of coal are found corresponding with them in bituminous matter.

With the arrangements already made for transportation by rail road to *Selma*, and thence to *Mobile* by the river, it will be easy to have a depot at the latter place, from which *New Orleans* and the Gulf may be supplied, and it would not be very sanguine to hope, that a similar depot may be established at *Key West*, to supply steamers touching at that port. It is difficult to estimate the expansion of a trade like that in coal, where the certainty of the means of supply is once established.

The liberal policy of the Directors of the Alabama & Tennessee Rivers Rail Road will leave nothing to be desired in the removal of every obstacle to transportation, and there only remain the economical and active operations at the mines, that require most special attention.

Statistics of Coal.—I would very respectfully recommend

the opening of the Pushmattahaw Beds as near the terminus of the proposed rail road and at as low a level as possible, as a large amount of your coal must be supplied from these beds.

The shaft will, of course, be sunk on the plane of the dip. The common *whim* will be sufficient during the sinking of the shaft, but afterwards a *steam engine* will be required.

From the beginning everything should be done in the best manner, the track in the shaft should be laid permanently, and the *trams* and other machinery of the best construction. The shaft should be divided by a brattice, one side being for the raising of the coal, and the other for ventilation, the pump-tackle, and gangway for the miners. As to the level beds, all the coal won at the pits now open, will be taken out, but no further expense incurred, working at the outcrop in this way, apparently simple as it is, is the most troublesome and expensive of all methods, to say nothing of the very limited quantity of the coal that can be won, where the outcrop is on the rise of the seam. The dip of the beds will indicate the proper position for the shaft from which the level seams should be worked. Between *Wood's Pit*, and the *Divis bed*, on the east, there is a difference of level of one hundred feet.

A miner of any experience would prove this part of the field by a few borings, that would not exceed in depth sixty yards each.

At all the pits arrangements should be made for dropping the coal from the trams, immediately on the screens; at present it is handled at least five times before it reaches *Selma*, each handling adding to the expense, and impairing the value of the coals.

I trust that the company will set the example, at the south, of discarding the absurd custom of disposing of coal by *bulk*, instead of *weight*. In closing this brief report, I cannot but express the pleasure I feel, in viewing this first, really business like attempt, to open and unfold the riches of one of our great mineral deposits.

M. Tuomey.

APPENDIX B.

ALTITUDES FROM RAIL ROAD SURVEYS.

1. SOUTH & NORTH ALA. R. R.

From F. L. Wadsworth, Engineer S. & N. Ala. R. R.

STATION.	ALTITUDE.
Montgomery	162 Feet.
Coosada	175 "
Elmore	199 "
Deatsville	300 "
Mountain Creek	542 "
Verbena	450 "
Cooper's	458 "
Clanton	596 "
Lomax	625 "
Jemison	706 "
Clear Creek	540 "
Calera	502 "
Whiting	555 "
Siluria	464 "
Pelham	427 "
Helena	400 "
Cahaba Mines	400 "
Brock's	564 "
Shade's Creek	612 "
Ironton	652 "
Birmingham	602 "
Boyle	524 "
Cunningham	440 "
Morris'	408 "
Warrior	549 "
Reid's	592 "
Blount Springs	434 "
Bangor	468 "
Gilmer	538 "
Phelan	692 "
Cullman	802 "
Milner	840 "
Wilhite	608 "
Falksville	603 "
Hartselle	673 "
Flint	569 "
Decatur	577 "
Harris	564 "
Foot's	618 "
McDonald's	665 "
Athens	709 "
Hay's Mill	753 "
Elkmont	798 "
Tennessee Line	

2. Savannah & Memphis R. R.

From President Alexander.

STATIONS.	S.	T.	R. e.	ALTITUDE ABOVE PENSACOLA.
Opelika	7	19	27	819 Feet.
Uchee Creek	...	...	..	774 "
Ridge	...	...	...	800 "
Loblocco	...	...	...	709 "
Gold Hill	13	20	25	770 "
Maddox	...	...	...	811 "
Big Sandy Creek	...	...	...	656 "
Ridge	...	...	...	736 "
Little Sandy Creek	...	...	...	660 "
Camp Hill	16	21	24	738 "
Creek	...	...	...	662 "
Dadeville	4	21	23	760 "
Buck Creek	..	...	...	670 "
Jackson's Gap	...	...	...	695 "
Manoy Creek	...	...	...	640 "
Ridge	...	...	...	683 "
Sturdevant	9	22	22	502 "
Tallapoosa Bridge	6	22	22	525 "
Ridge	...	...	...	760 "
Youngsville	27	23	21	747 "
Socopatoy Road	19	23	21	805 "
Kellyton	23	23	20	
Socopatoy Creek	..	...	...	748 "
Baker's Creek	...	...	...	810 "
Goodwater	15	24	20	872 "
Wildcat Creek	...	...	...	810 "
Ridge	..	...	...	845 "
Hatchet Creek	6	24	20	790 "
Pine Grove Church	...	...	...	889 "
Valley	...	...	...	820 "
Rayfield's Gap	18	22	5	896 "
Valley	...	...	...	842 "
Thomas' Gap	12	22	4	870 "
Syllacauga	29	21	4	590 "
Oden's Mill	18	21	4	508 "
Ridge	...	...	...	549 "
Childersburg	20	20	3	452 "

3. ELEVATIONS FROM SURVEYS MADE,

By R. A. Hardaway, Civil Engineer, from 1850 to 1870.

Locality.	County.	S.	T.	R.	Valley or Ridge.	Elevation.	Base.
Greenville	Butler	..	..	..	Ridge	450 ft.	Gulf
Pigeon Creek	"	18	10	16	Valley	296	"
Patsaliga Creek	"	28	11	17	"	383	"
Blue Creek	"	16	11	18	"	375	"
Near Rocky Mount	Montgomery	12	11	18	Ridge	598	"
Oakey Streak	Lowndes	1	10	16	"	513	"
Chunnenuggee	Bullock	33	14	24	"	625	Atlantic.
Cupia Hatchee	"	23	14	24	Valley	432	"
Cowikee Creek	"	5	14	26	"	342	"
" "	"	..	..	..	"	310	"
Columbus, Ga.		..	..	..	City	265	"
"		..	..	..	River	200	"
Union Springs	Bullock	..	..	..	Ridge	516	"
Cupia Hatchee	"	5	14	24	Valley	400	"
Calebee Creek	"	21	15	24	"	390	"
Old Stage Road	Macon	10	16	25	Ridge	455	"
Ocassee Creek	"	3	16	25	Valley	380	"
Chewacla Creek	Lee	9	18	26	"	475	"
Opelika	"	18	19	27	Ridge	870	"
Mount Jefferson	"	18	20	27	"	840	"
Osenuppah Creek	Chambers	18	21	27	Valley	665	"
LaFayette	"	12	22	26	Ridge	865	"
Milltown	"	19	24	26	Valley	642	"
High Pine Creek	"	3	24	25	"	625	"
Louina	Randolph	12	22	10	"	620	"
High Pine Mountains	"	5	21	13	Ridge	1,320	"
Wedowee	"	..	..	..	"	1,021	"
Wedowee Creek	"	33	19	11	Valley	775	"
Little Tallapoosa	"	20	19	11	River	757	"
Dividing Ridge	"	22	18	10	Ridge	1,100	"
Big Tal'poosa, Nixon's F'd.	Cleburne	..	..	..	Valley	780	"
Riddle's Bridge		29	17	10	River	815	"
Summit Cahulgee Gap, Daviston	Cleburne	5	16	10	Ridge	925	Selma.
					Coosa & Tal. waters	120	
						1,045	Savannah.
Coosa Water.							
Corn Grove Creek		..	..	..	Valley	780	"
Dividing Ridge "Dug-down" Mountain		..	..	..	Ridge	1,045	"
Tallapoosa Water.							
Cahulgee Creek		..	..	..	Valley	890	"

Elelations of the different Stations on the Selma, Rome & Dalton Rail Road above tide-water of the Alabama river.

STATIONS.	FEET.	MILES FROM SELMA.
Selma	147	..
Veto.	185	6
Burnsville	207	9
Clay's.	218	13
Peeples'	238	18
Plantersville	266	22
Dixie	307	27
Maplesville	381	31
Coxe's	398	35
Randolph	573	38
Bibb Mills	471	42
Ashby	481	48
Brierfield	413	50
Montevallo	494	55
Calera	522	62
Gardner's.	567	64
Shelby Springs	554	66
Columbiana	560	72
Wilsonville	452	81
Coosa River	445	84
Coosa Station	472	86
Childersburg	441	89
Kymulga	451	95
Alpine	495	98
Barclay	534	103
Talladega	586	109
Curry's	565	115
Munford	646	120
Silver Run	655	124
Oxford	678	129
Blue Mountain	816	134
Jacksonville	653	144
Harris	709	150
Patona	714	156
Cross Plains	722	157
Ladiga	696	159
Amberson.	727	162
Griffith's Mills	716	164
Sword's Mills	766	165
State Line.	930	171
Prior's, Ga	844	173
Cave Springs	697	180
Six Mile	709	190
Rome	652	197
Rives'	658	...
Harbers	673	220
Dalton	782	235

APPENDIX C.

Statistics of the Iron Industry of Alabama.

1. *Alabama Iron Company.*

Post-Office, Alabama Furnace, Talladega county, Ala., on Selma, Rome & Dalton R. R. S. S. Glidden, President; Jas. L. Orr, Treasurer.

This Furnace was started October 1, 1873. Only one stack 41 feet high; 8 feet 8 inches across the bosh; open top. Furnace yields from 20 to 22 tons of foundry iron per day. Hot blast; 3 blowing cylinders, 40 inches in diameter, and 6 feet stroke; steam cylinder 21 inches in diameter and 6 feet stroke; fuel, charcoal; ore, brown hematite; ore beds about half a mile from furnace; limestone about the same distance.

2. *Tecumseh Iron Company.*

Post-Office, Tecumseh, Cherokee county, Ala., on Selma, Rome & Dalton R. R. Willard Warner, President and Manager, Tecumseh, Ala.; W. F. Mason, Secretary and Treasurer, Rome, Ga.

This Furnace was put in blast February 18, 1874. One stack 12 by 60 feet, with top closed by bell and hopper; capacity, 20 tons per day; present yield, 15 tons; product, hot blast charcoal pig iron; blowing cylinder 84 inches diameter, 48 inches stroke; steam cylinder, 36 inches diameter, 48 inches stroke; engine run by 4 boilers in two batteries; boilers 50 feet by 40 inches; engine upright, direct action, from the works of Messrs. Ainstie, Cochran & Co., Louisville, Ky. Ore, brown hematite, from beds in the immediate vicinity of the furnace; limestone at two points within a quarter of a mile from the furnace; fuel, charcoal, made in bee-

hive ovens, in which the yield is 50 bushels of coal to the cord of wood.

3. *Stonewall Iron Company.*

Post-Office, Stonewall, Cherokee county, Ala., on Selma, Rome & Dalton R. R., about three miles from the Georgia line. J. M. Selkirk, President; J. W. Bones, Secretary and Treasurer; Wm. Wurts, Superintendent.

One stack 40 feet high, 11 feet across the bosh, open top; yield per day, 18 tons; product, pig iron; hot blast; engine 100 horse power, horizontal; steam cylinder 22 inches in diameter, 6 feet stroke; blast cylinders, three in number, 36 inches in diameter, 6 feet stroke; fuel, charcoal; ore, brown hematite; ore beds, near the furnace.

4. *Shelby Iron Company.*

Mr. Walter Crafts, Superintendent; Col. J. S. Black, Assistant Superintendent. Mr. - - Witherby, Secretary. Near Columbiana, Shelby county, Ala.

This company has been active for thirty years. There are two furnaces. No. 1, 12 by 56 feet; No. 2, 14 by 60 feet. Average yield per day of No. 1 is first blast, 13 tons; second blast, 18 tons; third blast, 14 tons—in tons of 2,268 lbs. The first two blasts were on hot blast pig iron, and the last on car wheel pig iron. Furnace No. 1 blew out, December 15, 1874, having made a run of three years, nine months and fifteen days.

Furnace No. 2, went in blast January 6, 1875, and has made an average thus far (February 2, 1875,) of thirteen tons per day.

Size of Engine No. 1.—Blowing cylinder 66 inches, and 4½ feet stroke.

Engine No. 2.—Blowing cylinder 84 inches, and 4 feet stroke. Waste gases are taken from the tunnel head and used for heating the boilers.

Ore, brown hematite, and ore banks near the furnace. Limestone opening three miles from the furnace, at the terminus of a narrow gauge rail road. Fuel used, charcoal.

5. *Brierfield Iron Works.*

Post-Office, Brierfield, Bibb county, Ala., on Selma, Rome & Dalton R. R. T. S. Alviss, Superintendent. Now idle.

6. *Woodstock Iron Works.*

Post-Office, Anniston, Calhoun county, Ala., on Selma, Rome & Dalton Rail Road. A. L. Tyler, President; Samuel Noble, Secretary and Treasurer.

The furnace went in blast April 13, 1873. One stack 43 feet high, 12 feet bosh; closed top. Capacity, 500 tons per month; all pig metal for car wheel and foundry purposes. Blast, hot and cold; can change on cold blast in a few minutes. Blowing cylinder 72 inches in diameter, 4 feet stroke. Engine cylinder, 30 inches, and 4 feet stroke. Gas is used for heating the boilers.

Ore, brown hematite; ore within ¼ mile of the furnace, unlimited in extent; limestone, 4 miles distant; contains 99.24 Carbonate of lime.

7. *Cornwall Iron Works.*

Post-Office, Cornwall, Cherokee county, Ala.

I have been able to get no information concerning this furnace.

8. *Rock Run Furnace.*

Post-Office, Pleasant Gap, Cherokee county, Ala.; Selma, Rome & Dalton R. R.

9. *Eureka Iron Company.*

Post-Office, Oxmoor, Jefferson county, Ala., on S. & N. Ala. R. R. James Thomas, Superintendent.

The works here consist of two furnaces formerly used for making charcoal iron; they are now being remodeled for coke. The size of the furnaces, 14 feet bosh, 59 feet high; hearth 6 feet; tunnel head 14 feet.

One blowing engine, steam cylinder 36 inches and 4 feet stroke. Blast cylinder, 7 feet diameter and 4 feet stroke.

There are 6 boilers, 50 feet long; four are 42 inches in diameter, the other two 28 inches.

Coke ovens at the furnace, 28 in number; built upon the horizontal or Belgian system, 24 feet long. Height of coke in oven $4\frac{1}{2}$ feet. To spring of the arch from the bottom, 5 feet. Ore, Red mountain fossiliferous ore, mixed with one-fourth limonite. Limestone comes from Red Mountain, below the ore.

10. Cahaba Iron Works.

Post-Office, Irondale, Jefferson county, Ala.; Alabama & Chattanooga R. R. Thomas & McKee, Lessees. Now idle.

11. Iron Works.

Post-Office, Woodstock, Bibb county, Ala.; Alabama & Chattanooga R. R. Mr. Giles Edwards, Superintendent. Has not yet been put in blast.

12. Central Iron Works.—Rolling-Mill.

Post-Office, Helena, Shelby county, Ala., on South & North Ala. R. R. R. W. Cobb, President; R. Fell, Jr., Secretary; R. Fell, Superintendent.

This establishment has 4 puddling furnaces, and one heating furnace; 3 engines, of which one of 120 horse power drives the mill; 1 muck mill; 1 guide and hook mill complete; shears, squeezer, and punches necessary for the operation of the mill.

The manufacture of the Alabama Loop Cotton Tie is made a specialty. Capacity about 1,000 tons per year.

Geological Survey

of

ALABAMA.

REPORT OF PROGRESS FOR 1876.

BY
EUGENE A. SMITH, Ph. D.,
State Geologist.

MONTGOMERY, ALA.:
W. W. SCREWS, STATE PRINTER.
1876.

To His Excellency,

GEORGE S. HOUSTON,

Governor of Alabama:

SIR—The Report of Progress of the Geological Survey, for the year 1876, is herewith respectfully submitted.

I have the honor to be, sir,

Your obedient servant,

EUGENE A. SMITH,

State Geologist.

UNIVERSITY OF ALABAMA,

November 30, 1876.

TABLE OF CONTENTS.

PREFACE.

In pursuance of the plan followed in previous years, the field work of the Survey during the past season, has been devoted chiefly to the Siluriàn formations exposed in the anticlinal valley, known as Roup's Valley and Jones' Valley. Incidentally, the geological formations, more recent than the Silurian, exhibited in this valley, have received attention. It has been seen in previous reports, that the Silurian formation in Alabama is the great repository of iron ores. In the valley, in part described in this Report, both the red and the brown ores occur in great abundance and of superior quality. The banks of brown ore are in some parts of the valley, of extraordinary extent. The close proximity of the ores, both red and brown, to the coal fields of the Warrior and Cahaba, will, some day, make this one of the chief centers of the iron industry in Alabama.

To the knowledge of the Coosa coal fields, we are enabled to make in this Report a small contribution, in the determination of the limit towards the south and southwest of this field. The capabilities of this portion of the field are, as yet, almost unknown.

The objects of the Survey include, amongst other things, the study and description of the fauna and flora of the State, and as the first contribution in this direction, we present with this Report a list of the Fresh Water and Land

Shells of Alabama, with remarks upon their Geographical Distribution, from the pen of Dr. James Lewis, of Mohawk, N. Y., one of the first authorities on this subject.

The labors of Dr. Lewis, in the conchological department of the National Museum of the Smithsonian Institution, are well known to Naturalists. To the working student of Natural History, this paper will be heartily welcomed.

It is due to Mr. Truman H. Aldrich, of Montevallo, to state that it is owing to his liberality that we are enabled to publish this list, as he has defrayed the entire expense incurred in its preparation.

To the authorities of the Alabama and Chattanooga, and the South and North Alabama Rail Roads, acknowledgments are herewith made for the continuation of courtesies extended to the Survey in previous years.

Prof. Wm. C. Stubbs, of the Agricultural and Mechanical College, and Prof. R. B. Fulton, of the University of Mississippi, have taken an active part in the field work during the past summer, and it is my pleasant duty to recognize here obligations to them for the assistance they have rendered.

A general acknowledgment of the indebtedness of the Survey to individuals, at whose hands many favors have been received, is hereby made.

EUGENE A. SMITH.

University of Alabama, November 30, 1876.

ROUP'S AND JONES' VALLEYS.

INTRODUCTORY.

In his first Report on the Geology of Alabama, Prof. Tuomey, in speaking of the Silurian rocks of this part of the State, says: "They (the Silurian rocks) are visible about sixteen miles in a straight line south-east of Tuskaloosa, where the waters of the Big Sandy Creek have removed the overlying loose materials that cover the surface of this part of the State. From this they extend north almost without interruption, to the head of Murphree's Valley, separating the Warrior coal field on the west from that of the Cahaba on the east. In this direction they are confined to a series of continuous valleys, that rarely exceed seven or eight miles in breadth; they are, in truth, but one valley, although designated by different names. The southern extremity has received the name of Roup's Valley; the middle portion, which includes the towns of Jonesborough and Elyton, and extends to Village Springs, is called Jones' Valley; whilst the part between the Village Springs and the upper extremity, where it is lost in the Racoon Mountain, has the appellation of Murphree's Valley."

The fact that this valley occupies the summit of an anticlinal fold was also noticed by Tuomey.

During the past season, the field work of the Survey has been devoted chiefly to the examination of the southwest portion of the valley known as Roup's and Jones' Valleys.

Before proceeding to the description of the geological

structure of the valley, it may be well, for the convenience of the reader, to give a short table of the sub-divisions of the Silurian, Devonian and Carboniferous formations.

A more extended description of these formations, as exhibited in some parts of Alabama, will be found in my Report for 1875.

Beginning with the lowest, these sub-divisions are:

A.[1] Lower Silurian.

1. Acadian.
2. Potsdam.
3. Calciferous—Knox Sandstone.
4. Quebec— { Knox Shale. Knox Dolomite.
5. Chazy.
6. Trenton.
7. Utica.
8. Cincinnati.

A.[2] Upper Silurian.

1. Niagara.

The remaining sub-divisions of the Upper Silurian have not yet been observed in Alabama.

B. Devonian.

1. Hamilton (?) Black Shale.

C. Carboniferous.

1. Siliceous Group. } Sub-Carboniferous.
2. Mountain Limestone. } Sub-Carboniferous.
3. Coal Measures—Carboniferous.

As we meet in this valley for the first time, with considerable exposures of the rocks of the Niagara period, which were only casually mentioned in my Report for 1875, a more detailed description will not be out of place here.

The New York geologists, to whom we owe the classifi-

cation and description of the Silurian beds, have divided the Niagara into three groups, as follows, beginning with the lowest:

1. *Medina*—Including the Oneida Conglomerate, and the Medina Sandstone.

2. *Clinton.*—Sandstones and Shales, with beds of lenticular and fossiliferous red iron ore.

3. *Niagara.*—Shales and limestones.

Of these three groups of the Niagara period, so far as is known, only the second, *the Clinton*, has been certainly identified in Alabama. In Tennessee, the group has received the name of the *Dyestone Group* from Prof. Safford, on account of the occurrence in it of the red ore, or dyestone. In Alabama, no more fitting name could be given to it than the *Red Mountain* group, for outcrops of the rocks of this group are found in ridges, or mountains, as they are called, extending almost without interruption from Bibb county to Georgia, and beyond. From the red ore, which seems always to be present in them, in greater or less thickness, these ridges have the local name of the Red Mountain.

The name Clinton, however, has already been applied to this group of rocks, and a multiplication of names for the same thing is to be avoided if possible.

The rocks of the Clinton group in Alabama, are chiefly thin sandstones and shales, which are variously colored—green, yellowish, brown and red colors being predominant. The group contains also several beds of lenticular or fossiliferous red iron ore. For characteristic sections of the strata of the Clinton group, the reader may be referred to the section near Tannehill, and that at the mines of the Eureka Company.

The sandstones and ore beds of this formation, hold, locally, great numbers of characteristic fossils, amongst which *Pentamerus oblongus*, usually represented by the casts of the interior of the shell, and varieties of corals and

bryozoans, are nearly always found. So far as the fossils go, there is no reason for thinking that any of the Oneida and Medina rocks are represented in the Red Mountain ridges of Roup's and Jones' Valley.

GENERAL ACCOUNT OF THE GEOLOGICAL HISTORY AND STRUCTURE OF THE VALLEY.

During the period of disturbance, which, according to the geological authorities, followed the deposition of the Coal Measures, a comparatively narrow belt of land, running approximately parallel to the outline of the Atlantic coast, from the Green Mountains and beyond, down to Alabama, was pressed up into numerous wrinkles or folds. This belt has received the name of the Appalachian region, and includes the Blue Ridge and the Alleghany Mountains. Going across this region from the Atlantic, northwestward, we should accordingly expect to find a series of ridges with trough-like depressions between; we should expect to find the strata of the ridges sloping away southeast and northwest from the axis of the ridges, and the strata of the depressions sloping both ways towards the central line or axis of the depressions; in other words, we should expect to find a series of *anticlinal* ridges and *synclinal* troughs. The atmospheric agencies, during the long period which has elapsed since the disturbances alluded to, have, however, tended to obliterate the features thus impressed upon the land, by wearing down the crests of the ridges, and in some cases filling up the depressions between them, so that almost the whole of what now constitutes the scenery of this region—its mountains and valleys—is the result of denudation. The strata are still found lying at various inclinations to the horizon, sloping sometimes on both sides away from a central line, and sometimes on both sides towards a central line; but the anticlinals do not now mark the ridges, nor the synclinals the valleys, but the ridges or mountains, as we now find them, owe their prominence,

generally, to a capping of harder strata, such as sandstones, &c., which has resisted denudation, whilst the valleys have been excavated out of the softer materials, such as limestones, and the like.

But there are other sources of complication in the geological structure of this area. The strata have sometimes been too stiff and unyielding to *bend* into the sharp folds into which they have been pressed, and the result has been a break or crack along the line of greatest strain, *i. e.*, the top of the fold, just as we can break a sheet of stiff card board by bending it up into a close fold. The fissure thus produced has furnished a channel for the denuding streams which have excavated valleys along the crests of anticlinal ridges. In this way, the anticlinal valleys have been formed. And then, in many instances, the strata have yielded still less to the folding, the fracturing has been still more profound, and the strata on one side of the fracture have been pushed up over the corresponding strata on the other side, producing dislocations, or *faults*, as they have been termed. These faults are often miles in length, and the vertical displacement varies from a few feet up to thousands.

Flexures and faults are common throughout the whole of the Appalachian region, which has its southwestern termination in Alabama.

The valley which we are describing lies at the southwestern end of this region, and an account of its geological structure will, it is hoped, be more easily understood after the foregoing remarks.

As already noticed by Prof. Tuomey, this valley occupies the summit of an anticlinal fold, having the coal basin of the Warrior on the west, and that of the Cahaba on the east. A simple reference to the map will show that it is the water shed between these two coal basins, for all the creeks having their sources in the valley, soon break through the ridges of Millstone Grit at the base of the Coal Measures, and make their way into the Warrior and Cahaba. The rugged, barren hills of the coal fields contrast

strikingly with the rolling, fertile lands of the valley, and we have presented here, as has been remarked by Prof. Safford, the curious case of a valley which is higher than the mountains. The geological structure of the region is, in general, as follows: In the middle of the valley, the strata belong to that sub-division of the Lower Silurian which I have called Quebec or Knox Dolomite; these rocks are found dipping generally towards the southeast, though in many places they dip both northwest and southeast. Crossing from the center of the valley southeast, towards the Cahaba coal fields, we go over the rocks of the Chazy and Trenton, the Niagara, the Black Shale, the Sub-Carboniferous, the Millstone Grit, and the Shales and Sandstones of the Coal Measures, all lying conformably and dipping southeast. Going northwestward, we find the same succession of strata up to the Coal Measures of the Warrior fields, the dip being sometimes northwest, though often southeast, a fact to be explained further on. Such, in the simplest terms, is the geological structure, and there is no doubt but that the coal basins of the Warrior and the Cahaba were once continuous; that at the time of the disturbances along the Appalachians, alluded to above, they, together with the underlying formations, down at least to the Quebec or Knox Dolomite, were uplifted into a long anticlinal fold; that this fold was fractured along its axis or summit, thus affording a channel for denuding waters; and finally, that the great mass of sandstones, coal beds, shales and limestones, which constituted the fold, has been broken down and removed by the action of running waters, till nothing is left of it now except a low rim on each side, adjacent to the Coal Measures.

The structure of the entire valley, however, is not always that of a simple regular anticlinal, with its beds sloping away on both sides from the center. In the southwestern extremity, the fold has been lapped together and pushed over towards the northwest, reversing the dip, so that all the strata dip southeast, and the newer rocks on the northwestern side are found *under* the older ones. As

a further complication of the structure, it may be added that in many places there are faults or dislocations, by which, on the one hand, some of the beds have been concealed, and, on the other hand, some have been duplicated. Instances of both kinds of faults will be noticed in the details below.

The narrowness of the valley, six to eight miles, from coal field to coal field, and its abundance of iron ores, consisting of limonites, and of the fossiliferous red ores, the latter forming part of a ridge on each side of the valley, the practically inexhaustible quantity of good limestones, combine to render this portion of the State peculiarly adapted to the production of iron.

GEOLOGICAL DETAILS.

Going southeast from Tuskaloosa, towards Scottsville, rocks of the Coal Measures form the country as far as the Hardy Clements old place, in S. 25, T. 22, R. 8, W. Along this road, coal has been dug at times at Kennedale, at Mrs. Armistead's, S. 30, T. 21, R. 8, W., at Mr. Bowen's, S. 22, T. 22, R. 8, W., and at many other places. At Mr. Bowen's, on Lie Branch, is the last exposure of coal, so far as is yet known, towards the south, and a short distance below his place the deposits of the drift cover everything.

At Mr. Ben. Clements', on the old Hargrove road, about S. 3, T. 24, R. 7, W., the waters of Big Sandy have cut through the Millstone Grit, here exposed in two heavy ledges standing nearly vertical and striking almost north and south. This is the lowest exposure of this rock yet observed, and here the distinctive features of the anticlinal valley seem to be lost under overlying drift. The lithological characters of the Millstone Grit here, as at all other places where it has been observed in this valley, are those of a quartzose sandstone, or sometimes a conglomerate. Under the lens, it is seen to be composed almost

exclusively of quartz grains, and is very unlike, in appearance, the ordinary sandstones of the Coal Measures.

The ledges of this rock are exposed on both sides of the creek; on the south side they can be traced only a short distance, but northward and northeastward, as far as Birmingham, and, indeed, probably to the head of Murphree's Valley, the same rock is found in nearly vertical ledges, marking the western limit of the valley.

Going from this lowest outcrop of the Millstone Grit, northeastward, no well-defined exposure of the red ore of the Clinton group was observed, though a sandstone, having many of the characteristics of the Clinton sandstone is seen on the old Hargrove road, a mile or two southwest of the Hardy Clements old place, and at the last named locality, the strata of Knox Dolomite are seen in great force. It seems probable that the Knox Dolomite outcropping here, belongs to the lower beds of the group, for there are many strata of a blue banded argillaceous limestone, such as characterize the lower part of the Dolomite elsewhere, at Montevallo for instance.

At the ford, a thin bedded limestone strikes nearly north and south, dipping east, but a short distance higher up the creek, the characteristic sandy dolomite, with rough, hacked surfaces, lies in thick beds, striking north 15° east, and dipping southeast 35°–40°. Several beautiful and bold springs burst up from beneath the dolomite. One of these, the Blue Spring, so called from the color of the water, has a basin about ten feet square. The water boils up in considerable volume, and this spring, which is about half a mile above the ford, is a fair type of the numerous limestone springs which characterize this formation.

Strata of the Knox Dolomite are exposed along the course of Big Sandy, below Clements', at least as far south as S. 2, T. 24, R. 7, E., of the lower survey. Northward from Clements' they are seen along a little branch, tributary to Big Sandy, in sections 24 and 18, T. 22, R. 8, W., upper survey, and northeastward are outcrops at intervals

along Big Sandy, in sections 24, 25, 17 and 16, of T. 22, R. 7, W. At the latter place are the lime kilns.

At Mr. Frank Goodson's place, S. 2, same township and range, these rocks are observed again, continuing thence probably without material interruption northeastward to Vance's, and up the valley. From Goodson's south, or a little southeast, to Mars P. O., and on to the Hill place, they make the country. Beyond Hill's, in this direction, we soon come upon the rocks of the Cahaba coal fields. The intervening rocks, viz: Chazy and Trenton, Clinton, Black Shale, and Sub-Carboniferous, I have not noticed in this immediate vicinity, though they are seen fully developed a few miles further northeast.

In going northward from the Hardy Clements place to Clements' Station, on the A. & C. R. R., in S. 1, T. 22, R. 8, W., the way lies through the pine woods of the Coal Measures, (Warrior,) after passing the outcrop of Knox Dolomite, already mentioned. The Millstone Grit and other intervening strata between the Knox and the Coal Measures, were not exposed along the route traveled.

In the vicinity of Clements' Station, numerous openings have been made for coal, some of which were visited.

At Johnson's mine, in S. 2, the seam of coal is 18 to 24 inches in thickness, in two benches separated by a few inches of shale. These numbers apply to the exposed bed at the mouth of the mine. The roof is a hard sandstone, 8 to 10 feet thick, and the floor fire clay. Above the sandstone is a thick bed of conglomerate, with pebbles sometimes as large as the end of the thumb. This rock, which is exposed in this vicinity, in all the little depressions caused by denudation by the tributaries of Lie Branch, resembles very much a conglomerate overlying some of the coal beds at Tuskaloosa.

Other openings, said to be upon the same bed as Johnson's, are those of Devereux Brown, Hardy Clements and Hewitt. About one mile further southwest is the Jones bed, and two miles beyond, the Bowen bed mentioned above. All these are on Lie Branch. Further up the

creek is the Woodel bed, and in S. 1, T. 22, R. 8, W., the R. H. Clements bed, from which place outcroppings of coal may be seen at intervals to the station.

At the present time, no work is going on at this Clements mine, though a large amount of coal has been raised here. The thickness of the seam is 39 inches, and the quality of the coal said to be very good. I believe that preparations for renewing the work are now in progress.

Across the railroad, north of the station, and within the distance of two or three miles, are likewise several coal openings, which, however, are now lying idle. On account of the caving in of the ground over the openings and the water in the pits, there was no chance to see any of the coal seams.

The beds where examined, have a very slight dip, and there seems to be no very good reason why they might not be reached by a shaft at the station, by which the expense of hauling in wagons, over rough roads, and from distances of half a mile to three or four miles, might be avoided.

At the old stage stand, about one mile from Clements' Station, are some fine springs of freestone water, known as Wheelock's Springs.

East of Clements' Station, at the intersection of the Huntsville with the Scottsville road, the chert of the Knox Dolomite is observed, but from that point to Smallwood's Station, it is generally covered by the drift. At Smallwood's, the Dolomite is the surface rock again. At Vance's Station, strata of a flaggy limestone, nearly vertical, and full of fossils, are shown in a railroad cut. East of this station, the pine woods hills are covered with a ferruginous sandstone, similar to that so common in the drift. This sandstone, in places, is rich in iron, and pieces which might be very fair samples of limonite, are not uncommon. This passage of ferruginous sandstone into limonite has already been noticed in Bibb county, near Pratt's Ferry, near Ashby Junction, &c., and other occurrences of it will be described beyond.

Northwest of the railroad, at Vance's, and within the

distance of two miles, we find the Millstone Grit well exposed. This rock is seen in two or three ledges. The first of these, nearest the railroad, stands nearly vertical, with a slight slope, however, to the southeast. Where a branch has cut through this rock, I observed, in several places, strata of yellowish shales, with surfaces coated with a thin black film. These shales, like the Millstone Grit, are almost vertical, and distant only 50 to 60 feet from it, southeast. They are probably shales of the Sub-Carboniferous formation, since similar shales have frequently been noticed occupying a similar position with reference to the Millstone Grit on both sides of the valley above this point.

Some two hundred yards northwest of the first bed of Millstone Grit is another bed of quartzose sandstone, precisely similar, and, like the first, nearly vertical, though a slight inclination was noticed towards the northwest.

At a short distance still further northwest, nearly horizontal, beds of a coarse grained quartzose sandstone are encountered, and beyond these the sandstones and shales of the Warrior field.

A few miles northeast of Vance's, very much the same exposures of rocks may be seen. The first beds of Millstone Grit, making high and precipitous cliffs, mark the limit of the valley towards the west. Below these, at the very foot of the cliffs in fact, the black and yellowish Sub-Carboniferous shales are exposed wherever a little branch has cut through the hard rim of sandstone, the shales having about the same dip as the sandstone, nearly vertical. At one point, the Knox Dolomite and the sandstone were seen in clear exposures, separated by a ravine not more than 100 yards across; the strata of the Dolomite dipping southeast, at an angle of 45° or less, the sandstone nearly vertical, say dipping 85° southeast.

In offering an explanation of these facts, we have to bear in mind that crossing from the Knox Dolomite of the valley at this point westward, instead of encountering in succession the strata of the Chazy and Trenton, Clinton, Black Shale, &c., we come from the Dolomite, in less than one

hundred yards distance, directly upon the Millstone Grit, with a few feet of Sub-Carboniferous shales exposed below it. All the strata between the Knox Dolomite and the Coal Measures, except the few feet of Sub-Carboniferous, have disappeared.

We have here a fault by which the Dolomite of the Lower Silurian has been pushed up against the rocks of the Coal Measures, thus covering the strata between. That besides the vertical displacement, there has been also a sliding of the lower Silurian rocks upon the upturned and folded back or reflexed edges of the Carboniferous strata, seems probable when we consider the difference in dip of the two sets of rocks.

This fault does not extend, however, very far towards the northeast, or at least the vertical displacement seems not to be so great, since west of Woodstock there is a well defined ridge of Clinton rocks, with accompanying red ore, between the Dolomite and the edge of the Coal Measures.

The presence of almost *horizontal* beds of hard quartzose sandstone, apparently identical with the Millstone Grit, and not more than five hundred yards west of the *vertical* beds of the latter rock, is a noteworthy fact.

These horizontal beds of sandstone are sometimes found lying bare over considerable areas. One of these, the "Eight Acre Rock," as it is called, is a bare rock, (thirty or forty acres in extent,) composed chiefly of quartz grains, with some strata of a conglomerate, with pebbles as large as peas.

Lithologically, this differs very much from the ordinary sandstones of the Coal Measures, and resembles nothing so much as the Millstone Grit near it, and with which it is no doubt identical.

This would give, at a rough estimate, over eight hundred feet in thickness to this bed.

On the "Eight Acre Rock," the beds are intersected by two sets of joints, running northeast and northwest respectively. Some of these joints have widened out into fissures of several feet, and twenty to thirty feet deep. The sur-

face of the rock has been weathered into numerous little elevations and depressions, the latter filled with white sand, support a scanty growth of a Hypericum, and one or two other hardy herbs. Besides these, only the prickly pear (cactus) and patches of yellow lichens obtain a hold upon the bare rock. At the western edge is a large cave, formed by a projecting ledge.

In some respects, this reminds one of the "flat rocks" of granite in the Metamorphic regions of the State.

Above Vance's, and near Mrs. Dowdell's, the Cherty Dolomite forms several rocky knobs, and in one of these is a cave with fine stalactites. The smoke of torches has blackened the surface of these, but when broken off they show handsome crystalline structure.

Above Vance's Station begin the beds of limonite, which have directed so much attention to Roup's Valley. At the intersection of the Huntsville and Columbiana roads, is one of these ore banks, of considerable extent. Between this and Bibbville, the hills are usually covered with drift, and the concretionary ferruginous conglomerate, before mentioned, is of universal occurrence.

At Bibbville, a manufactory of fire brick was an object of interest. The material for the brick is obtained from large pits close to the station. It consists—1, of a tolerably white and plastic clay; and 2, of a moderately coarse grained arenaceous deposit, made up of grains of quartz sand, held together by a clayey cement. The baked brick, when examined with the lens, resemble, to some extent, specimens of Millstone Grit, the quartz grains being a prominent ingredient.

These bricks are much used in the construction of the furnaces and rolling mills, and are highly recommended by those using them.

Near Esquire Green's, a few miles southeast of Woodstock, is a fine exposure of the Chazy limestone, in the usual characteristic ledges along a hillside. A rough measurement gave some four hundred feet thickness of the strata.

The lower beds held numerous shells of *Maclurea magna*, which seemed to be absent from the uppermost beds.

The fossils of these upper beds have more resemblance to Trenton fossils. At this outcrop, the strike is N. 26° E. and the dip S. E. 30°. Further towards the southeast come, in regular succession, the yellowish fossiliferous sandstone of the Clinton age, with its red ore; chert, with fragments of crinoidal stems, of Sub-Carboniferous age; (the Black Shale between these two formations was not noticed at this point;) Millstone Grit, and the beds of the Cahaba coal field. The Clinton and Sub-Carboniferous, with Black Shale included, are usually associated together on each side of the valley in a tolerably well defined ridge, generally lower than the ridge of Millstone Grit, though sometimes, as near Jonesborough and Birmingham, it is higher. At this point, however, neither of the formations mentioned forms a prominent ridge.

The dip at all the outcrops noticed was southeast.

Woodstock, in S. 15, T. 21, R. 6, W., is upon the central Knox Dolomite of the valley. At this place a furnace has been erected by Mr. Giles Edwards, which has not yet gone into blast. Near the furnace is an ore bank near outcrops of cherty Dolomite, showing a moderate dip 10°—15° southeast.

Caffee's Branch, which has its source not far from Woodstock, runs, for the first two miles of its course, through beds of limonite. At the head of the branch is one of the most extensive of these deposits.

Through the courtesy of Mr. Edwards, I am enabled to give an analysis of this ore, made by Dr. T. M. Drown, of Lafayette College, Easton, Pa.

Analysis of Limonite from head of Caffee's Branch.

Iron (metallic)	50.68
Insoluble (silica, &c.,)	9.80
Sulphur	none
Phosphoric Acid	0.31—0.12 Phosphorus.
Alumina	3.75
Manganese	none

The following analyses of limonite, from near Woodstock, will fairly represent the quality of the ore at this point:

	No. 1.	No. 2.	No. 3.
Combined water	11.35	12.14	11.55
Siliceous matter	2.46	12.16	2.98
Sesquioxide of iron	84.46	75.04	82.83
Alumina	0.91	0.30	1.39
Oxide of manganese	0.33	0.00	1.02
Lime	0.26	0.41	trace.
Magnesia	0.04	0.06	0.12
Phosphoric acid	0.58	0.00	trace.
Sulphur	0.14	0.14	0.14
Metallic iron	59.15	52.55	58.01
Phosphorus	0.25	none.	trace.

No. 1. From Tuscaloosa county, Section 9, Township 21, Range 6, west, near Woodstock Station. Analyzed by Prof. N. T. Lupton.

No. 2. Same locality, and analyst.

No. 3. " " " "

Greenpond Station, in S. 11, T. 21, R. 6, W., is near the southeastern edge of some very large limonite banks; the excellent quality of the ore will be seen by reference to the analyses below. A few hundred yards below the station a railroad cut has passed through an ore bed of considerable extent; southeast of the cut, the ore may be seen on the surface over several acres. This, I believe, is the property of Dr. Ragsdale of Greenpond, and to the same gentleman belongs another large deposit of ore, just east of Thomas' switch.

On the west side of the rail road at this place, Mr. Giles Edwards is engaged in raising ore for the Oxmoor Furnace, where it is used mixed with the red ore from the Clinton or Red Mountain strata. Mr. Edwards has erected here machinery for washing the ore, and a tram-way of one-fourth of a mile, connects his ore bank with the rail road.

Mr. Edwards has furnished me with these analyses of the ore taken from different localities on this bed, which has several acres superficial extent.

The analyses were made by Prof. Rœpper, of Lehigh University.

Analyses of Limonite from Edwards' Bank, near Greenpond.

	No. 1.	No. 2.	No. 3.
Sesquioxide of Iron.......	83.89	84.25	57.46
Insoluble, (Silica, &c.)....	3.28	3.10	34.03
Water....................	12.51	13.09	8.55
Phosphoric Acid..........	trace.	trace.	trace.
Metallic Iron..........	58.75	59.00	40.24

It will be seen that No. 3 was a clayey specimen. The excessively small quantity of phosphoric acid found in all three specimens, is rather remarkable for limonites.

About one-fourth of a mile north of the station, in S. 11, at various localities in S. 2, T. 21, R. 6, west, and also in S. 35, T. 20, R. 6, west, banks of limonite, remarkable at least for their vast extent, were visited. I have, as yet, no analyses made of the ores from these localities, and, of course, can say nothing of the proportion of phosphorus contained in them, but the per centage of metallic iron would probably average 55 per cent. Hills, one hundred feet and more in height, and several acres in area, composed, to all appearance, of almost solid limonite, are not rare in this vicinity; indeed, the limonite being more resistant to denudation than the calcareous rocks with which it is associated, forms a large per centage of the hills and smaller elevations for a distance of five or six miles northeastward. The soil upon these ore hills seems to be quite productive, and the hills desirable farming lands, if one may judge by the crops growing upon them, and especially by the tons of ore, which have been heaped up in piles, and walls, in order to prepare for the plough, small patches of ground.

Average samples of the ore from several typical localities in the vicinity of Greenpond have been collected, and the analyses of them will be presented at some future time.

In S. 15, T. 20, R. 6, west, the sandstones, &c., of the Clinton group, are found dipping southeast; these rocks hold three beds of the red ore, 7 feet, 4 feet, and 3 feet thick, respectively, and occupying about 40 feet of strata. These measurements were made by Mr. Edwards, and are given upon his authority.

Going northwest from this outcrop of Red Mountain rocks, we come within one-fourth of a mile, upon a stratum of Black Shale, followed by a ridge of bedded chert, and by one hundred and fifty to two hundred yards of dark blue calcareous shales, alternating with sandy calcareous rocks. These beds of chert and shales are Sub-Carboniferous, and dip at a high angle, 80° or more, towards the southeast. By the section above given it will be seen that they have been pushed over so that the newer beds are found *underneath* the older.

The Millstone Grit, which follows close upon the calcareous shales just mentioned, is exposed in a fine, characteristic section, where a branch of Davis' creek has cut its way through from the *Valley* into the *Mountains* of the coal measures. In this cut the rock stands nearly vertical, as was the case near Vance's, below, but passing through into the Warrior coal measures, the sandstones and shales pass rapidly into a more horizontal position, and within a mile of the vertical ledges of the Millstone grit, the rocks of the coal measures have very little dip. Near the center of S. 26, T. 20, R. 6, west, an opening has been made upon one of the lowest of the Warrior coal beds. The coal is in three benches, of about eighteen inches each, separated by two clay partings, the upper three inches, and the lower twelve inches thick.

If we compare the section across the valley here, with that at Vance's, described above, we find this difference: here the Knox Dolomite, instead of being almost in con-

tact with the Millstone Grit, or at most, with a few hundred feet only of Sub-Carboniferous shales between, as was the case below, is succeeded by the Clinton, Black Shale, and Sub-Carboniferous beds, (the Chazy and Trenton were not noticed here, but they occur a few miles northeast.) The faulting here has therefore not been so great, or in other words the Knox Dolomite has not slided over and concealed the newer beds to the extent noticed below. If there is any displacement here, it is comparatively slight, for, though no Chazy beds were observed, they would probably be found by a closer search. The two sections have, in common, the vertical (or nearly vertical,) beds of Millstone Grit, and Sub-Carboniferous, dipping as much as 85° S. E., thus bringing the newer *under* the older rocks.

There could hardly be a clearer instance of the inversion of strata than that shown here.

Near Tannehill station we have one of the best sections across the valley. The eastern side of the anticlinal being the simpler, its geological structure will be given first, and from this the more complicated relations of the rocks on the western side may be somewhat clearer.

Tannehill station is upon the central Knox Dolomite, near its upper beds, for within one-fourth of a mile from the station going eastward we find some 350 feet in thickness of beds of the purer limestones and dolomites of the formation exposed near the bank of the creek. Some of these beds weather very smoothly, showing tolerably uniform composition—some have been quarried for lime; others are light gray dolomite, breaking with smooth conchoidal fracture. A few layers of tolerably pure blue limestone are here intercalated.

Succeeding these are beds of rough sandy dolomite with much chert, making a cherty ridge which may be seen at the upper mill; characteristic exposures of this rough cherty dolomite are found at the mill and along the bank

of the creek for a short distance. The thickness of these beds is not less than 800 feet, and the dip like that of the section above, about 50°–52° southeast.

Limestones of the Chazy and Trenton groups come next, occupying a narrow valley between the chert ridge just noticed and the Clinton beds beyond.

The lower limestones at least, are of Chazy age, judging by the characteristic fossil *Maclurea magna.*

The dip corresponds with that of the beds below, and the thickness of the limestones is not far from 350 feet.

The Clinton strata are next encountered. These are chiefly standstones, with shales, and two or three layers of the red fossiliferous ore. The rocks of this group form a well defined ridge at this place, or rather, taken together with the lower, cherty beds of the Sub-Carboniferous group, they form a ridge which is, however, not so marked as it becomes further northeast. The thickness of these beds is between 380 and 390 feet. The following is a more detailed section.

Beginning below, next the limestones of the preceding group, the Clinton rocks are—

1. Thin-bedded yellowish sandstones, alternating with yellowish and greenish shales............155 feet.
2. Thick-bedded yellowish sandstones, alternating with thinner strata of the same rock... 80 feet.
3. Thin-bedded, flaggy sandstones............ 10 feet.
4. Red ore, thickness not ascertained.
5. Thin-bedded, yellowish sandstones, with some heavier layers 2-3 feet thick............. 30 feet.
6. Red ore, exact thickness not determined.
7. Heavy-bedded, yellowish or reddish sandstones 50 feet.
8. Shaly beds of greenish and yellowish colors 30 feet.
9. Shales with thin-bedded sandstones........ 25 feet.

Total thickness...............above 380 feet.

Seventy-five or eighty feet of strata were not seen (covered with soil) between No. 9 and the first of the chert beds to be described below. The Black Shale will probably be

found occupying part of this area, as it has been noticed a mile or two north of this section, between the Clinton and Sub-Carboniferous beds.

From the lower Mill down to the ridge of Millstone Grit, a fine opportunity is presented for the study of the Sub-Carboniferous rocks of this part of the Valley. They occupy an area of one-fourth of a mile or more across the strike, which would give not less than 800 feet vertical thickness. Although many of the beds are highly fossiliferous, the fossils have not as yet been studied sufficiently to enable me to give the equivalents in other states, of the beds observed here.

A section of the Sub-Carboniferous rocks at this place beginning below, at the lower mill, shows the following:

1. Heavy layers of bedded chert holding casts of crinoidal stems, and of brachiopod shells. These chert beds form the shoals upon which the dam has been built. The chert often resembles a porous friable sandstone from which calcareous matter has apparently been removed. In the chert, are subordinated beds of limestone, at least three: one of them a compact, gray, crystalline, crinoidal limestone; another, a dark blue fine grained rock.

Thickness of the cherty beds, about 200 feet.

2. Following these are at least 200 feet of calcareous strata, alternating with shales: some of these shales are black and quite fissile, others lighter colored and softer; all fossiliferous.

In this division there are two or three beds of limestone hard, compact and full of fossils; from beneath one of them issues a very fine bubbling spring, like those so common in the Knox Dolomite.

The great mass of the rocks, however, seems to be made up of impure argillaceous and sandy limestones, which weather into yellowish, brownish and reddish sandy rocks or shales—full of fossils as a general thing. These limestones, when fresh, are exceedingly hard and tough, and ring like a metal under the hammer. The dip of the beds wherever taken, was southeast, about 50°–55°.

I might add the following section of some of the beds of

No. 2 above, given more in detail, which will serve to show some of the characteristic features of the section. These rocks are exposed in the bed of the creek below the mill, and are, beginning with the lowest, (up stream):

1. Hard gray sandy calcareous rock, weathering into shales .... 30 feet.
2. Clay shales, soft, light colored.............. 30 feet.
3. Impure sandy limestone, laminated........ 8 feet.
4. Soft, light colored clay shales............... 20 feet.
5. Heavy bedded impure limestone, dark blue, and weathering into a sort of sandy rock.. 40 feet.
6. Black fissile shales with numerous shells of brachiopods............................ 40 feet.

The old Iron Works stand in the gap cut by the waters of Roup's Creek, through the ridge of Millstone Grit, which is here exposed in a very fine section. This ridge follows, going eastward, a narrow valley occupied by the shales and calcareous rocks of thè upper part of the Sub-Carboniferous section above. Beyond the iron works, eastward, is another narrow valley of Coal Measures shales, and then a considerable ridge of sandssone of the same formation.

The creek, like all others which rise in the valley, has cut through Millstone Grit, and the hard rocks of the Coal Measures. It flows into Shades Creek at no great distance from here. The first or lowest of the beds of Cahaba coal opened in this vicinity, is I think some three or four miles east or southeast of the forge.

On the opposite side of the railroad, and the northwest side of the anticlinal, we find the following:

From two and three-quarters to three miles, going across the strike, the valley is underlaid by beds of Knox Dolomite. Near the railroad, this formation has a narrow belt of impure cherty calcareous rocks, and the rest of it is almost literally an ore bank. From many localities, the

limonite has been dug to supply the old forge and other furnaces. As was the case further southwest, near Greenpond, most of the hills about Tannehill are nothing but accumulations of limonite. The ore here lies, generally, upon beds of shaly impure limestone, having the usual strike northeast, and a dip towards the southeast of 75°-80°. It would be manifestly a tedious undertaking to enumerate all the localities of the occurrence of the ore banks, some of them, however, which were examined have some points of interest. In section 30, township 20, range 5, west, on the property of Mr. John Salmonds,are several extensive beds. In section 36, township 20, range 6, west, the association of limonite with the ferruginous sandstone already spoken of, was particularly noticed. The greater part of the loose surface fragments at this place, consisted of grains of quartz sand cemented together with limonite, which is occasionally a tolerably pure limonite with fibrous texture. The quartz grains are about the size of those of the Millstone Grit. Here, as well as at almost every other deposit in the vicinity, this ferruginous sandstone, in plates, pipes, hollow balls, &c., similar to those which almost universally cap the hills of the Drift formation further south, are found mingled with larger and smaller masses of pure concretionary limonite. I give these particulars on account of the bearing which they may have upon the origin of the limonite. The conclusion seems to be justified that whatever agencies have been at work in forming the ferruginous rocks of the Drift, have also been active in producing the similar iron rocks and ores of this formation. On this point, however, more will be said below.

At the McMath place, in section 30, township 20, range 5, west, a fine spring issues from beneath the Dolomite. In the northern part of the same section, an outcrop of Chazy limestone occurs, and a short distance further northwest a ridge of the Clinton sandstones, with two or three seams of red ore. This is followed by beds of chert, with well defined Sub-Carboniferous fossils, (the Black Shale was not seen exposed,) and about one-eighth of a mile

northwest of the chert beds, over a narrow valley of shaly rocks, probably also Sub-Carboniferous, we find the nearly vertical ledges of the Millstone Grit as usual, and beyond these the Warrior Coal Measures.

All these beds west of the anticlinal axis, dip towards the southeast, showing, as was the case further southwest, an inversion of the strata.

This occurrence of Chazy and Trenton, Clinton, Black Shale and Sub-Carboniferous beds in regular succession on both sides of the Knox Dolomite, may be seen at any cross section of the valley between Greenpond and Birmingham, and in all probability beyond, to the head of the valley.

In addition to the simple anticlinal here noticed, we find from Bucksville, northeastward, as far as Elyton, at least, in a more or less continuous ridge, a repetition of the *trio* of formations, Clinton, Black Shale and Sub-Carboniferous, and sometimes the upper beds of the Chazy and Trenton group. From Bucksville to S. 36, T. 19, R. 5, W. this doubled set of formations is found as a well defined ridge, known in the vicinity as *McShan Mountain.*

We propose now to give some details concerning this curious feature of the valley.

In Tuomey's first Report (p. 16), there is a section across the valley at Bucksville with a figure, which will serve to explain the positions of the formations as there exposed. I give below the table of the strata as given by him, together with the formations to which they belong, as ascertained by subsequent investigations.

a. b. Millstone Grit, and Coal Measures of the Warrior and Cahaba, on opposite sides of the valley.

c. Black clay slate, } *Sub-Carboniferous.*
d. Cherty rocks, }

e. Yellowish sandstone and iron ore. *Clinton.*

f. Siliceous rocks containing stems of Crinoidea. *Sub-Carboniferous.*

g. Sandstone containing iron ore. *Clinton.*

h. Limestone. *Chazy and Trenton.*

i. Magnesian Limestone. *Knox Dolomite.*

i(bis). Limestone, *(Chazy and Trenton,)* not given in Tuomey's section, but seen east of railroad at Tannehill Station.

k. Yellow sandstone. *Clinton.*

l. Ridge of Cherty rocks.	*Sub-Carboniferous.*
m. Sandstone.	
n. Clay slate, underlying Millstone Grit.	

The section from *i.* to *n.* has already been described above, between the railroad and the Millstone Grit, at the old forge, and measurements given of the thickness of the strata. To the other half of the section, from *h.* to *c.*, I wish to call attention.

It will be seen that we have a repetition of the Clinton and Sub-Carboniferous rocks, *g.* and *f.*, and *e.*, *d.* and *c.* In Tuomey's figure, the Millstone Grit, *a.*, is represented as lying unconformably upon the slates and shales, *c.*, but I am inclined to think that in this particular, the section is faulty. In reality, the Millstone Grit stands on the western side of the valley, nearly vertical, or more correctly, it dips 85° or more towards the northwest, and the underlying Sub-Carboniferous shales have the same dip, which very gradually going westward, changes slightly to the southeast; at no point, however, being more than 5° from vertical, just as though the Millstone Grit, in the folding, had been pushed over *a little less* than the underlying rocks.

I do not think that Tuomey's explanation of the facts on p. 18 of his Report, viz: that the axis of the anticlinal is hidden beneath the Millstone Grit and Coal Measures, will hold good. The apparent unconformability of the Millstone Grit and the underlying rocks, exceedingly slight at most, can, I think, be better explained by assuming that the former being one of the upper beds of the great fold, and lying considerably to the westward of the axis of the fold, was less bent up than those beneath. Below this place, we find the Millstone Grit bent over still more, so as to slope the other way, *i. e.*, southeast, and the rocks of

the Coal Measures, which are undoubtedly conformably laid upon it, are seen a few hundred yards northwest nearly horizontal, or even dipping slightly northwest.

In a Report by Prof. J. P. Lesley, of Pennsylvania, upon the "Geological Structure of the Scott, Wise and Tazewell Counties, Virginia," there is described and figured a fault occurring in Abb's Valley, which I consider the counterpart of what may be seen in this valley, and the occurrence in such close proximity of the vertical sandstones of the Millstone Grit, and the horizontal strata of the immediately overlying Coal Measures is there explained in what seems to me the most convincing manner.

A precisely similar fault has already been noticed above, at Vance's Station, where it is exceedingly well defined. The same fault, with perhaps much less vertical displacement, occurs undoubtedly here, near Bucksville.

I am sorry that the means at my disposal are not sufficiently ample to enable me to reproduce the figure here; the reader is, therefore, referred to the paper by Prof. Lisley, above alluded to, and to the figure in Tuomey's Report, for a better understanding of what has been said.

As to the details of the doubled Clinton and Sub-Carboniferous beds at Bucksville, I can add the following: A few hundred yards northeast of the old McMath place, in S. 30, T. 20, R. 5, W., begins a ridge which, at its southwestern extremity, is covered with limonite of the Knox Dolomite. Near Bucksville, we find this ridge made up of the yellowish sandstones (holding beds of red iron ore) of the Clinton Group. Bucksville itself is near the junction of Knox Dolomite and Chazy, and the impure cherty dolomite of the former, with a large spring issuing from beneath, and the limestones of the latter can both be seen in the village and near the road. Back of the village, northwest, occurs the Clinton sandstone and iron ores, and at Bladoe's tan yard, the beds of chert of the Sub-Carboniferous with underlying Black Shale are shown in very good exposures in the bed of the branch. It seems that at this place there is even a local doubling of the Clinton

and Sub-Carboniferous interpolated beds, for we find two distinct outcrops of the red ore with bedded crinoidal chert between, in the immediate vicinity of the tan yard.

The exact details of this seeming anomaly, I was not able to get, and I merely mention this in passing. For our present purpose, it is sufficient to know that the trio, Clinton, Black Shale and Sub-Carboniferous, is found just back of Bucksville, at Bladoe's tan yard. All these rocks are nearly vertical, inclining 85 degrees, or more southeast, and this is to be remembered in connection with what will be said of their occurrence a few miles northeast of this point.

Now going northwest from Bladoe's, we pass in regular order (after the interpolated trio just described) the strata of Knox Dolomite, Chazy and Trenton, Clinton sandstones and red ore, (at this point called Red Mountain,) Sub-Carboniferous chert beds with crinoids, (Black Shale not actually observed,) and lastly, Millstone Grit.

It will be seen that this section agrees with Tuomey's, quoted above, except that the Millstone Grit is almost vertical, and not as represented in his section.

To the courtesy of Mr. Giles Edwards, I am indebted for the following analyses of the Red Ore from several localities near Tannehill. The ores are all from the western side of the valley.

	No. 1.	No. 2.
Metallic Iron	50.82	55.51
Silica, &c.	17.38	10.39
Sulphur	none	0.08
Phosphorus	0.09	0.06
Alumina	6.06	5.37
Manganese	none	0.44

No. 1 was made by Mr. J. B. Britton of Philadelphia; No. 2, by Dr. Thomas M. Drown, of Easton, Pa., both well known chemists. The percentage of phosphorus in these ores is exceedingly small.

Another specimen from S. 19, T. 20, R. 5w., by Mr. A. W. Kinzie, shows the following composition:

Sesquioxide of Iron.......	71.93
Silica, &c................	18.60
Water....................	0.60
Alumina, &c..............	5.25
Phosphoric Acid..........	0.32=0.14 Phosphorus.
Carbonate of Lime........	2.86
Metallic Iron.............	50.35
Phosphorus in iron........	0.28

These analyses show that the red ore on the western side of the valley is not inferior to that on the east.

Analyses of red ores from the Eureka Mines will be found below.

Five or six miles northeast of Bucksville, in S. 36, T. 19, R. 5, W., near Mr. James Moore's, is the other end of this ridge of Clinton and Sub-Carboniferous beds, called *Mc-Shan Mountain.* The beds at this place are perfectly exposed, and a section of the northwestern side of the valley shows this order of things, viz.:

From the Knox Dolomite in the valley, going westward we come upon this ridge about a mile from the railroad. At the base of the ridge are the beds of Chazy & Trenton limestones with characteristic fossils: the beds dip 35 deg. northwest, and not southeast, as was the case at Bucksville. Going over the ridge we cross, in succession, (1) Clinton Sandstones and ore beds, making up the greater part of the mass of the ridge; the ore beds are at least two, and probably three in number; they have been tested in a few places, and yield a very excellent quality of ore; these, like the Chazy strata, dip northwest. (2) Heavy beds of chert holding crinoidal stems and other fossils of the Sub-Carboniferous: the intervening Black Shale was not observed, being covered probably with the *debris* of the other beds.

(3) A valley on the other side of the ridge in which the chert and sandy dolomite of the Quebec or Knox group appear, forming a small ridge; beyond which (4) the Chazy & Trenton limestone is found in ledges nearly vertical—but dipping 80°–85° southeast. The upper strata of these beds are highly fossiliferous and crystalline, streaked with reddish veins. This marble is very firm, and would, if polished, show the beautiful markings which have rendered the Tennessee marble so justly celebrated.

Westward of these beds are, (5) (6) and (7), the usual trio of formations making a ridge, here called the Red Mountain, viz.: Clinton, Black Shale, and Sub-Carboniferous. The upper shaly beds of the Sub-Carboniferous are found in a narrow valley between the Red Mountain and the vertical ledges of Millstone Grit.

Nothing could be clearer than the repetition of the Chazy, Clinton, and Sub-Carboniferous beds shown by this section. The northwest dip of the repeated beds here, and their vertical position, or slight southeast leaning further south at Bucksville, are points worthy of notice.

Above this point, towards Elyton, I have noticed the same duplication of the Clinton, &c., groups, but they are not found as a distinct ridge, but only as slight elevations. Thus, near McAdory's Mill, in S. 12, T. 19, R. 5, W., there is a double outcrop of the Red ore formation; and again a short distance southwest of Elyton. The Red Mountain proper, which is at these localities a well defined ridge, separated from the Millstone Grit Cliffs by a narrow valley underlaid by Sub-Carboniferous shales, is the one farthest west. It is separated from the duplicate Red Mountain by a valley containing Chazy limestones and Knox Dolomite.

It seems that from a short distance above Bucksville, to within four miles of Elyton, the Knox Dolomite, which below Bucksville has been seen to be the most widely spread of the formations, loses its importance to some extent, and we find the limestones of the Chazy & Trenton groups in almost vertical ledges filling up a large proportion of the valley. With the decrease in the extent of the Knox strata, goes also a decrease in the number and importance

of the limonite beds. They are *not absent* in this area, but they are comparatively unimportant by the side of those extraordinary accumulations of ore in the vicinity of Tannehill, Greenpond and Woodstock.

In S. 33, T. 18, R. 4, W., near Mr. John Smith's, is an ore bank, and from that point northeast to Birmingham, extends a continuous well defined ridge of chert of Knox Dolomite age. Upon this chert ridge is the reservoir of the Birmingham water works. It seems to be in the upper part of the Dolomite; for, crossing it west of Elyton, we descend at once into a valley of Trenton or Chazy limestone.

On the eastern side of the valley between Tannehill and Jonesborough, the road passes over chert of the Knox Dolomite, and a better road could not be desired. East of Jonesborough Station, after crossing a narrow belt of Knox Dolomite, the usual rocks of the Red Mountain are found, viz.: Chazy and Trenton, Clinton and Sub-Carboniferous, (the Black Shale not seen.) At this point the red ore is of good quality apparently, and in very great quantity.

At Old Jonesborough, the rough looking dolomite of the Quebec Group (Knox Dolomite) occurs in heavy ledges, dipping from 30 deg. to 35 deg. southeast. Between that and the station, is a low flat country with occasional outcrops of a laminated argillaceous limestone, resembling Chazy, but not yet determined satisfactorily. It lies between strata of undoubted Knox Dolomite on the west (at Old Jonesborough), and beds of the same group on the east, (between the station and the Red Mountain.)

A mile or less from Jonesborough Station, on the eastern edge of the valley, occurs a fine pond spring issuing from Knox Dolomite. A dam thrown up a few feet from the source of this spring gives sufficient fall for a mill wheel a short distance below.

Above Jonesborough, as has been intimated above, the center of the valley is occupied by the nearly vertical ledges of the Chazy limestone presumably, which are seen dipping both southeast and northwest. The geological structure of the valley at this point needs further investigation, since

the position of this limestone, in the midst of the valley with Knox Dolomite on each side of it, makes its precise relations a little obscure. Four miles southeast of Elyton may be seen the top of an anticlinal in this bedded, nearly vertical limestone, where the Dolomite seems to have been pushed up through it.

Above this point the larger part of the valley is occupied by the Dolomite, the chert ridge on the west, above alluded to, being a prominent feature. East of Elyton and Birmingham, the Red Mountain becomes a very well defined ridge, and much work has been done, in places in laying bare the red ore and raising it for shipment.

At the foot of the Red Mountain, on the western slope here, some of the finest specimens of concretionary chert yet found in Alabama have been collected. These specimens, some of which are many square feet in area, show a surface full of rounded protuberances, which are composed of chert in regular concentric layers. The outer layers have, in most cases, been worn or broken off, and the laminated shells, ball within ball, are beautifully displayed.

Going from Elyton to Oxmoor, we have the following section well displayed. (1) The clay beds of the Knox Dolomite, with a chert ridge of same formation near the Red Mountain. (2) At the base of the Red Mountain an outcrop of Chazy limestone. (3) The Red Mountain with the usual sandstones, shales and ore beds of the Clinton age. (4) In, or just beyond, the gap are the thick ledges of bedded chert of Sub-Carboniferous age, followed by a level space, probably underlaid by the shales of the same group. (5) Next, the Millstone Grit, which thus forms almost a part of the Red Mountain here, being separated from it by the narrow belt of Sub-Carboniferous shales mentioned. Descending from the Millstone Grit ridge, we come (6) into the valley of Shades Creek, here wholly within the Coal Measures, and not between the Red Mountain and Millstone Grit. Shades Valley is in the shales of the Cahaba Coal Measures, between the ridge of Millstone Grit on the west, and some precipitous bluffs of sandstone

on the east. These bluffs are the broken edges of carboniferous sandstones, which hold locally great numbers of impressions of *calamites* and other coal plants.

The Millstone Grit, from near Grace's Gap, has been used by Mr. Thomas in the construction of the hearth of the Oxmoor furnace, for which purpose it is most admirably adapted. The rock thus used, contains from 97 to 99 per cent. of silica.

A section of the Clinton strata, near Oxmoor, given below, has been made by Mr. L. S. Goodrich, of Birmingham. He recognizes two distinct deposits of ore, separated by about sixteen feet of ferruginous sandstones. The uppermost of these two deposits is about two feet thick, and is not known to hold any considerable bed of ore fit for use. No analysis of the ore from this part has been made. Below the sixteen feet of sandstone underlying the first deposit, comes the workable bed, made up of seven strata of ore interbedded with thin bands of shale.

The section, beginning at the top and descending, is:

1.	No. 1.	Ore	7	feet	3	inches
2.		Trace of shales and pebbles...				
3.	No. 2.	Ore	8	"		
4.		Shales	0	"	3	"
5.	No. 3.	Ore	2	"	3½	"
6.		Shale	0	"	0¾	"
7.	No. 4.	Ore	1	"	2	"
8.		Shale	0	"	1¼	"
9.	No. 5.	Ore	1	"	2½	"
10.		Shale	0	"	2	"
11.	No. 6.	Ore	0	"	11	"
12.		Shales	7	"	0	"
13.	No. 7.	Ore	1	"	3	"

Below these beds are forty to sixty feet of Argillaceous sandstones, followed by limestone.

This limestone is the Trenton or Chazy, which is found underlying the Red Mountain throughout the valley.

The ores from these seven beds were carefully selected by Mr. Goodrich, and analyses of them made by Dr. Otto Wuth, of Pittsburgh, Pa. These analyses I am enabled to give through the courtesy of Mr. Goodrich. The numbers correspond to the numbers of the ore beds of the section above.

Analyses of Red Ores, from Eureka Company's Mine, five miles below Birmingham, by Dr. Otto Wuth.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Silicic Acid	16.31	31.62	32.04	31.83	31.16	31.91	16.73
Alumina	3.76	4.16	5.13	4.46	4.64	4.05	2.01
Peroxide of Iron	78.55	62.45	59.97	60.51	59.87	60.32	66.84
Lime	0.68	1.03	......	......	......	......	......
Magnesia	0.21	0.34	......	......	......	......	......
Phosphoric Acid	0.49	0.42	0.45	0.45	0.43	0.45	0.38
Sulphur	Trace.	......	......	......	......	......	......
Carbonate of Lime	......	......	......	......	......	......	......
Metallic Iron	54.98	43.71	41.98	42.36	41.91	42.22	46.79

The limestone of the underlying Trenton or Chazy formation has also been analyzed by the same chemist, as also a limestone from a bed in the Sub-Carboniferous series in Shades Valley.

The analyses show that these limestones are well adapted to serve as fluxes, especially No. 2, from the Sub-Carboniferous formation.

Analyses of Limestones, near Eureka Furnace, in Jefferson County, by Dr. Otto Wuth.

	No. 1.	No. 2.
Water	0.11	0.10
Organic Matter	0.07	0.06
Silicic Acid	2.13	5.32
Alumina	0.21	0.71
Peroxide of Iron	0.12	0.08
Carbonate of Lime	90.60	93.40
Carbonate of Magnesia	6.74	0.32
Phosphoric Acid	0.016	0.011

The success of the Oxmoor furnace, with coke as a fuel, has been already demonstrated. It was at this place, under the superintendence of Mr. L. S. Goodrich, that the first coke iron made in Alabama, was turned out. The coke first used here was made, I believe, from coal mined from the Gould Seam, and afterwards from the Wadsworth seam at Helena.

ECONOMIC MATERIALS.

COAL.—The coal fields of the Warrior and the Cahaba bound the valley on either side, and their distance apart is, below Birmingham, never greater than seven or eight miles. The line of the Alabama and Chattanooga railroad does not pass into the coal area on either side until below Smallwood's Station, it enters the Warrior field, through which it passes thence to Tuscaloosa. Near Clements' Station, as will be seen above, many openings have been made for coal, and from that point on to Kennedale, seven miles from Tuscaloosa, are several coal stations. Nothing but the unsettled condition of the affairs of this road has prevented an extensive business in the mining of coal along this portion of the road.

FIRE-PROOF MATERIALS.—At Bibbville is a bed of clay and sand, which is made into fire bricks.

The fire brick manufactory of Mr. Flournoy has already been mentioned in the details above. Besides the brick for ordinary grate backs, this establishment has furnished bricks for the stacks of smelting furnaces at various places, and for the puddling furnaces at Helena.

The Millstone Grit being almost pure quartz, is one of the best of fire proof materials. Some varieties of it are of course better suited to the purpose than others. It is near the A. & C. railroad in many localities, *e. g.* Vance's, Tannehill, &c., and on the South and North railroad, at Grace's Gap. This rock has been used at the Oxmoor furnace for the lining of the hearth, and for this purpose it is unequalled.

MILLSTONES.—The Millstone Grit which bounds the valley on each side, has its name from the almost universal use made of it, wherever it occurs, the world over. There are several localities on the borders of the valley where the rock has been extensively quarried for millstones, and unfinished or broken millstones are not unfrequently found in riding over the rocky ledges.

LENTICULAR OR FOSSILIFEROUS RED IRON ORE.—The "Red Mountain," is a name which has long been current in Alabama. It is applied to the ridges of Clinton Sandstones holding beds of red iron ore, which are found on both sides of the valley, and which have been traced with very little interruption from Pratts' Ferry, on the Cahaba, above Centerville, to the Georgia line, and beyond that into other States. In Tennessee the Dyestone ridges are the equivalents of our Red Mountain.

The quality and amount of the ore vary from place to place along these outcrops. Sometimes the admixture of siliceous material is too large; again, the ore is exceedingly pure, as may be seen from analyses given.

The ore banks of the Oxmoor furnace have been, perhaps, the best tested and explored of any in the State, and the result shows that when properly selected this ore rivals the brown ore. The quality of the iron produced at the Oxmoor furnace is now well known.

In this connection, I may once more call attention to the fact that the group of strata holding the red ore, is *duplicated* on the western side of the valley, from Bucksville, nearly to Elyton, and that the interpolated Red Mountain ridge, holds in some places, at least, where personally visited, some very excellent ore. The McShan Mountain, as this ridge is called, in the lower part of its course, is not more than a mile from the railroad, at most places.

As to the *extent* of the beds, here sliced off from the main Red Mountain, future careful explorations and measurements are required to give that accurately, and future investigations will probably, also, show exactly how such

a long strip came to be cut off from the main, and dropped or slided down to its present position.

LIMONITE OR BROWN IRON ORE.

The Knox Dolomite of the Lower Silurian, which underlies the greater part of this valley, is here, as at other points in the State, the limonite-bearing formation. Wherever it is most widely spread, there we may look for the greatest accumulations of limonite. Mere superficial extent, however, of the Knox Dolomite does not appear to be the only condition favorable to large accumulations of limonite. We saw in Talladega county, and elsewhere (Report for 1875,) that the most extensive ore-banks were generally found between the mountain ranges of Potsdam Sandstone on the west, and the Metamorphic area on the east. In other words, where the disturbances, uplifts, &c., have been the greatest, the ore-banks are most numerous and extensive. So here, the limonite banks are most abundant where we find evidences of the greatest amount of displacement of the strata.

The commonly received explanation of the origin of the limonite, viz., that it is the result of the decomposition of ferruginous limestones and dolomites, by which the calcareous portions have been gradually removed, whilst the iron collecting together, in concretionary masses, has been deposited in beds of varying extent, near the site once occupied by the original rock, seems to hold good for the ore banks, so far as they have yet been examined in Alabama.

In some parts of this valley there is evidence to show that the Knox Dolomite, and overlying rocks have been pushed up into an anticlinal fold not only of great *vertical* height, but, also, *closely pressed* together, so that the strata all stand nearly perpendicular, or all dip in the same direction. The subsequent decomposition of this great vertical thickness of ferruginous limestones, has left correspondingly large accumulations of limonite. This appears to have been the case in the lower part of the valley, be-

low Jonesborough. Above that, however, to Elyton, at least, the vertical height of the anticlinal seems to have been much less, (see details above,) and we find in this area only a few ore-banks, and these, comparatively small.

Whilst the Knox Dolomite of the Lower Silurian appears to be the original source of most of the brown ore in Alabama, the formation of the *ore-banks,* as now observed, must be ascribed to a much later period. And, in this connection, it seems to me that something may be learned from the association of Drift deposits with beds of limonite in many localities.

In Bibb county, Talladega county, and in this valley, many instances have been noticed where a ferruginous sandstone or conglomerate, formed by the cementing together by limonite, of grains of sand or pebbles of quartz, is associated with masses of limonite quite pure. The association of the two is frequently so intimate that upon one and the same specimen both are sometimes found. This ferruginous sandstone in flat layers, pipes, hollow spheres, &c., is one of the most common occurrences in the Drift, and in the cases just alluded to, other materials of the Drift, such as rolled pebbles, beds of sand, &c., are also, associated with the sandstones and limonites.

Whatever agencies, therefore, have been active in forming the ferruginous sandstones and conglomerates usually ascribed to the Drift, have also been instrumental in forming part, at least, of the limonite with which they are so intimately associated.

COOSA COAL FIELD, AND ADJACENT FORMATIONS.

GENERAL CONSIDERATIONS.

By a reference to Prof. Tuomey's Map, it will be seen that the Coosa Coal Field, as there laid down, extends no further west than the line between Ranges 1, east, and 1, west, and no further south than the upper half of Township 20.

During the summer of 1875, I noticed in several places, much further south and west than the points above mentioned, the occurrence of Sub-Carboniferous beds, as well as of sandstones and slates, which I could refer to no other formation than that of the Coal Measures.

During the past summer this section of the State was again examined, and the limits (towards the west and south,) of the Coosa Coal Field, established with some degree of accuracy from near Helena, southward to where the lower formations are covered by Drift. The map accompanying this report will show the line thus traced out.

Before going into local details it may be well to give a general section, across the strike of the strata, passing through Helena, from the Warrior Coal Field across Roup's Valley, through the Cahaba Field into that of the Coosa. In this way, perhaps, a very good general idea of the relations to each other, of these three Coal Fields may be given.

Beginning on the west with the Coal Measures of the Warrior, and going southeast, we descend, *geologically*

speaking, through the Millstone Grit, Sub-Carboniferous, Black Shale, Clinton, Trenton, and Chazy, to the Knox Dolomite, which is the lowest formation exposed in the anticlinal valley between the two fields; then *geologically ascending*, through the same series, we reach the Coal Measures of the Cahaba. Crossing this field with its numerous plications, but with its strata generally dipping southeast, we find at Helena, a fault by which the Coal Measures are cut off, and the sandstones of the Knox Group—equivalent in all probability to the Calciferous Sandstone of the northern geologists,—brought up to their level. From this fault we cross, going southeast, the Sandstone, Shale, and Dolomite of the Knox Group, then Chazy and Trenton limestones, and immediately following these, so far as has yet been made out, the chert beds and Shales of the Sub-Carboniferous formation, the Millstone Grit, and Coal Measures of the Coosa field.

Thus, whilst the Warrior and Cahaba fields are separated, in this section of the State, by a narrow anticlinal valley, with the Knox Dolomite as the lowest formation exposed, the Cahaba measures are cut off on the east by a fault bringing Knox sandstone up to the Coal; and another point to be noted, is the seeming lack of all the Upper Silurian beds, beneath the Coosa field, whilst beneath the Warrior and Cahaba fields, only a few miles westward, these Upper Silurian beds are found exceedingly well developed in the Red Mountain, geologically below the Coal Measures both of the Warrior and the Cahaba. The thickness of the Clinton strata as measured in Roup's valley at one point, is not less than 400 feet, and this may be considered as below the average thickness, for further north, the Red Mountain becomes a very well defined ridge.

This complete thinning out of Upper Silurian beds from a thickness of 400 feet and upwards, in the short distance of ten to fifteen miles across the Cahaba fields in the vicinity of Helena, is an interesting fact. Whether the same conditions hold northeastward of Helena, I am not yet able

to say, but from information derived from others, I am inclined to think that they do.

As to the economical value of the three hundred square miles and upwards, of territory, thus found to belong to the Coal Measures, little can be said as yet. The fact, that workable beds of coal have not yet been laid bare in this area, and the occurrence in the midst of this coal field of the limestones of the underlying Sub-Carboniferous formation, would seem to speak against any great thickness of coal bearing rocks, thus far towards the southwest, still the field must be more thoroughly investigated before certain knowledge of its capabilities can be obtained.

With these preliminary general observations we may pass on to the local details.

DETAILS.

1. Quebec, Chazy, and Trenton Formations.

At Helena the strata of Knox Sandstone and Knox Shale, on the east side of the fault by which the former has been raised to the level of the Coal Measures, are very well exposed along the South & North Alabama Railroad, and I am able to give some additional details as to thickness of the beds, &c.

The dip of the beds varies from about 62° next to the Coal Measures to 52° at the top of the Shale; these two formations show here, an aggregate verticle thickness of from 1,000 to 1,100 feet; the line of demarcation between the two, it is impossible to draw.

A section of these beds shows the following, beginning geologically below, next to the line of fault:

(1.) Sandstones, thick and thin bedded, interstratified with the gray, green, buff, brown, and chocolate colored shales, which are so characteristic of the lower parts of the Knox group, about 270 feet.

(2.) A bed of gray sandy dolomite, 10–15 feet.

(3.) Two or three heavy beds of hard gray sandstones,

forming the knoll upon which the office of the Central Iron Works stands, and forming also the greater part of the shoals upon which the dam has been built, say 50-60 feet.

(4.) Alternating beds of dolomite and shale, with perhaps some sandstone layers, mostly covered by surface soil, but showing exposed surfaces of dolomite in many places between the office and the Rolling Mill, say 150 feet.

(5.) From this point to the bottom of the Knox Dolomite which overlies the Shale, there is a succession of thin beds of calcareous sandstones and the usual handsomely colored characteristic shales, about 500 feet.

In No. (5) of the above section and about 180 feet below the top of the Shale in one of the ledges of calcareous sandstone, I found several fragments of trilobites, which have not yet been identified. The rock from which they were taken, upon a fresh fracture resembles a hard compact blue limestone, but upon a weathered surface it looks like a buff colored sandstone. Most of the thick layers in this subdivision, when a fresh fragment is broken, resemble limestones more than they do sandstones. At the outcrops however, the calcareous matter has usually been weathered out, and they present only the sandy remnant.

For the estimation of the thickness of the Knox Dolomite, just overlying the Shale near Helena, I have not the data. Crossing it, however, in the direction of the dip, *i. e.* southeast, we find about 400 yards of country underlaid by rough, sandy, dolomite, and upon that an enormous accumulation of cherty beds, about a mile across, forming a well defined chert ridge which may be traced without interruption, marking the uppermost part of the Knox Dolomite, from near Helena southward by Alexander's Mill, till it is lost under the Drift below Montevallo.

East of this cherty ridge is found a narrow valley of Chazy and Trenton limestones, and then the ridge formed by the bedded fossiliferous chert of the Sub-Carboniferous formation.

An inspection of the map will show the position of the valley of Chazy and Trenton limestone which lies between

the chert ridge of the upper part of the Knox Dolomite on the west, and another chert ridge of Sub-Carboniferous age on the east.

These three formations are found in their regular order all the way southward to where they are covered by the Drift.

Some local details of these three groups of strata will come properly at this place, and in giving the details I shall begin with the lowest and describe them in ascending order.

In the Report for 1875, I described the Dolomite where it adjoined the Cahaba CoalMeasures between Montevallo and Helena. At this time, therefore, I shall speak only of the upper (eastern) part of the Dolomite which is so well characterized by accumulations of chert which make a well defined piney woods ridge from Helena to below Montevallo.

West of the limestone valley at Siluria, this ridge is seen back of Dr. Tichenor's place, and at points near Siluria, some beds of brown iron ore have been discovered, but I have seen no analyses of the ore.

South of Mr. Holt's Lime Kiln and near Elliottsville, the chert turns eastward to Whiting, which is on its eastern edge. Elliottsville is upon this cherty portion of the Knox Dolomite, and at Warren's Mill, section 25, township 21, range 3, west, there is a very large funnel shaped depression, or lime sink, from which the water is pumped for the engine.

Below Whiting, on the edge of the Dolomite, considerable search has been made for workable beds of limonite. Analyses of ore from this vicinity were given in my Report for 1875.

Going southward from Elliottsville on the Montevallo road, the way is over the cherty beds and through piney woods to Mr. Moore's, in S. 35, T. 21, R. 3, W., where the red lands of a lower subdivision of the Dolomite are entered. These red lands are found continuously then southward to Montevallo, with the exception that a strip of Knox

Sandstone and Shale is found with northeast strike and southeast dip, apparently thrust up through the Dolomite. This strip (which will be more particularly described below) terminates abruptly near Mrs. Denson's, S. 2, T. 22, R. 3, W., no trace of it being found much to the northeast of this point.

If from Moore's we turn eastward by the Columbiana road, we come, about S. 36, T. 21, R. 2, W., upon the chert again, and it is found making a considerable ridge southward by Alexander's Mill, where it is also well displayed.

In going from Montevallo towards Calera, a ridge, or rather, a succession of ridges of this chert are crossed soon after leaving town, and the huge concretionary masses of the chert which have either been rolled aside in working the road, or have been left partially exposed in the road, have no doubt left a vivid impression upon every one who has driven over this way.

Spring Creek, and some other tributaries of Shoal Creek, rise on the western side of the chert, and do not break through it, but are turned southwestward below Montevallo to flow into the Little Cahaba.

South of Montevallo, the lower formations are almost entirely obliterated by the sand and pebble beds of the Drift, which cover every thing for many miles.

Returning now to Siluria, we find, east of the chert, a narrow valley in which the projecting edges of the strata of Chazy and Trenton limestones are seen like a series of low walls running parallel with the course of the valley.

Here, as at many other points where it occurs, the limestone is much used for lime burning. Maj. Wagner's and Mr. T. G. Holt's kilns, at Siluria, Mr. Reynolds' at Whiting, and Dr. Hale's, near Montevallo, are all located upon this belt, and the lime made at these points is well known in the market.

Below Siluria this belt turns eastward, then southward, and in township 22, southwestward, as shown by the map.

Buck Creek has its principal sources in this limestone cove east of Whiting, whence it follows the valley westward and northward to Pelham, where it breaks through Knox Dolomite, Shale and Sandstone, into the Cahaba coal fields, and flows into the Cahaba river. The creek makes between Siluria and Whiting, an S-shaped curve corresponding to the contour of the limestone valley, or to the chert ridge of Knox Dolomite on one side, and the chert ridge of Sub-Carboniferous on the other.

In the neighborhood of Calera is found an isolated patch of this limestone, apparently cut off from the western belt just described. It is probable, however, that the two areas have been continuous, but this continuity is hidden by the overlying Drift, south of the Selma, Rome & Dalton Railroad. If we follow the edge of the limestone formation, where it joins the Sub-Carboniferous, we find the beds of the former always dipping at considerable angles under those of the latter.

Thus, near Dr. Hale's Lime Kiln, the limestone dips southeast under the Sub-Carboniferous chert, cut through by the railroad at the "Gap of the Mountain." Crossing then going eastward, the narrow strip of Sub-Carboniferous rocks and Coal Measures, we come into the Calera limestone, which now dips northwest, north, and around to the east, always *under* the crescent-shaped ridge of Sub-Carboniferous rocks, that bounds the northern part of the Calera area. South of the Selma, Rome & Dalton Railroad the outcroppings of limestone, both of the Calera patch and of the western belt, may be followed for a mile or two, and then they are hidden by the Drift, but the numerous lime-sinks and depressions, let us infer the presence of the limestone beneath the Drift for several miles further south.

From Squire Whatley of Calera, I obtain the information that the limestone is exposed about seven miles southeast of Montevallo on the Montgomery road; this is probably the continuation of the western belt of the limestone below Dr. Hale's. Again it comes to the surface in SS. 15 and 22 of T. 24, R. 13, E., of the lower survey.

Economical Products.—Throughout this entire area of Chazy & Trenton rocks there are many beds of limestone which are shown by analysis to be almost pure carbonate of lime, and it is, therefore, not surprising that the Shelby lime ranks with the very best. Aside from the lime, I know of no other useful material to be derived from this formation.

I should mention, however, that *heavy spar*, or sulphate of baryta, is found in many places in the limestone, and sometimes quite pure and white, and in considerable quantity. Thus, east and north of Whiting, are several well known occurrences. This mineral is often ground up and mixed with white lead in several proportions, giving the paints known as Venice White, Hamburg White, and Dutch White.

The *limonites* of the Knox group have already been mentioned.

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2. Sub-Carboniferous and Coal Measures.

East of Pelham is seen a sharp ridge running nearly north and south. This ridge is formed chiefly by the heavy beds of crinoidal chert of the Sub-Carboniferous formation. It may be traced southward to Siluria, where the railroad passes through a gap in it; below Siluria it bends around towards the east, and is cut again by the railroad at Bragg's Tank, in S. 12, T. 21, R. 3, W. From Bragg's Tank it curves northward, eastward, and then southward, enclosing all of section 8, and parts of 7 and 9, of T. 21, R. 2, W., in a sort of cove which is underlaid by the limestones already described. It continues its southern trend to the lower part of township 21, where Camp Branch cuts through it. Below this, under the name of *Harkins' Ridge*, it is cut again by the railroad about S. 9, T. 22, R. 2, W.; and it may be followed thence sothwestward, by Mr. Sentill's and Squire Whatley's, to the "Gap of the Mountain," where it is cut by the Selma, Rome & Dalton Railroad. Below this it is covered almost entirely by the Drift. The

general direction of the dip of the strata is east or south-east, always *away* from the limestone valley.

Where the ridge makes a curve, the direction of the dip of course varies, but it is always *towards* the coal measures and *away* from the limestone. The occurrence at Calera will be mentioned below, after giving some details of the region just traced out.

Near Siluria, east of the cherty ridge, shales of yellowish and blackish colors, form a narrow valley of about half a mile in width, and then follow the abrupt and broken edges of the Millstone Grit, here as elsewhere, a purely siliceous rock, with quartz grains or pebbles. The ledges of Millstone Grit form a well defined ridge following all the sinuosities of the chert ridge, and at the distance of about a quarter or half mile from it.

At Patton's Mill, S. 6, T. 21, R. 2, W., the ledges of the Grit strike N. 60° E. and dip N. W. at an angle of 54°. A small tributary of Buck Creek rising in the Coal Measures, breaks through the Conglomerate here, making a very narrow gorge, the sides of which are so close together that a dam of ten feet length is sufficient to confine the water for an overshot wheel 35 feet in diameter, a few yards below.

There are few scenes more worthy of the pencil of an artist than those found wherever the Millstone Grit has been broken through by a comparatively insignificant branch. The tough, hard rock, yields only enough to allow the water to pass through, making deep, narrow gorges, with towering. precipitous cliffs of sandstone on each side.

In this tributary of Buck Creek, and several others further north, the waters rise in the Coal Measures of the Coosa field, break out into the limestone valley and across it into the Coal Measures of the Cahaba.

Beyond the ledges of Millstone Grit are the shales and sandstones of the Coal Measures extending eastward nearly to the Coosa river.

The sharp curve made by the Sub-Carboniferous chert

between Siluria and Bragg's Tank, is repeated by the Millstone Grit, and we find a sharp turn in the direction of the ledge, in the corner of SS. 1 and 12, of T. 21, R. 3, W., and S. 6 and 7, T. 21, R. 2, W. This doubling back of the conglomerate forms quite a conspicuous knob at the point indicated. So also the sandstones of the Coal Measures where they turn at a corresponding sharp angle, form a high bluff of several hundred feet, known as the Stony Butte. This is near the northeast corner of S. 6, T. 21, R. 2, W.

I am informed by Dr. Tichenor that coal has been reported as found in this vicinity, about four or five miles from Siluria.

East of Whiting, Camp Branch has its source in the limestone cove spoken of, flows south parallel to the chert ridge to the lower part of the township, where it turns abruptly east, cutting through the ridge, flowing through the Coal Measures into the Waxahatchee.

The slates exposed in the bed of Camp Branch near Shelby Springs, were mentioned in my Report for 1875, but the geological position of them was not entirely evident.

It is plain however, now, that they must be referred to the Coal Measures. The coal measures between the Sub-Carboniferous ridge east of Whiting and Columbiana, were partially examined last year and many points of interest observed.

The Millstone Grit is found in its place about one quarter of a mile east of the chert ridge, then follow the sandstones and shales of the Coal Measures to Columbiana, with an exception presently to be mentioned. Characteristic of nearly all the fragments of sandstone in this area, are the brilliant crystals of quartz which cover some of the surfaces. The crystals are generally quite small.

On pages 121 and 122 of my Report for 1875, will be found conclusions reached from observations of last year, as to the extent of the Coosa coal fields towards the south and southwest, and it will be seen that the explorations of

this year, have shown that my conjectures were perfectly correct.

A strip of limestone, considered by Prof. Worthen to be of the age of the Chester Limestone, is found running through the midst of the coal field. The manner in which this underlying limestone has been brought to light through the coal measures, whether by denudation or by a fault, will be an important point to settle in forming an estimate of the probable thickness of coal bearing rocks in this field.

In township 22, below where Camp Branch cuts through it, the chert ridge is known as *Harkin's Ridge*, and its course may be seen by a reference to the map.

In S. 8, T. 22, R. 2, W., it turns abruptly, and does so, not by a continuous curve, but in a broken one, thus:

This formation of a curve by broken lines will explain the recurrence in several alternations with each other, of Sub-Carboniferous chert and Chazy limestone, noticed last year between Montevallo and Calera.

An outcrop of Millstone Grit was observed about one mile north of the S. R. & D. R. R., near this place.

If we go from the "Gap of the Mountain," where the R. R. cuts the Sub-Carboniferous ridge, towards Calera, we cross a synclinal of Coal Measures, about one mile wide, underlaid on each side by Sub-Carboniferous Chert and Chazy and Trenton Limestone.

The Chert ridge on the eastern side of this little synclinal, curves (in a broken line as described above) around towards the north and east just back of Mr. Thompson's house, then southeast by Mr. Dare's new limekiln, and finally south and southwest, enclosing thus an area of limestone about two and a half miles from east to west, and about two from north to south; the southern limit of it being, as already said, obscured by the Drift.

Immediately beyond the Sub-Carboniferous ridge are

the shales and sandstones of the Coal Measures, and a thin seam of coal about two inches in thickness, was cut through in digging a well in S. 16, T. 22, R. 2, W. (near the middle of the section). This upon the authority of Mr. Dare.

Near Mr. Thompson's house, a quarry exposes some beds of dark colored argillaceous limestone, which is fossiliferous, but from which no well defined forms have been obtained. This limestone, which has been much used as a building stone for culverts, &c., lies under about eight or ten feet of black fissile shales. The dip of the beds is towards the northeast and the strike a little northwest. They are undoubtedly Sub-Carboniferous beds, but their position, whether above or below the chert beds, I can not give with certainty. At this point they seem to be *under* the chert.

From Mr. Dare's Kiln, the chert ridge has a southwesterly direction and can be traced several miles before it is hidden by the Drift.

East of this point are found the sandstones and shales of the Coosa Coal Measures on to near Columbiana, except where interrupted by the limestone exposure near Shelby Springs.

The geological age of the slates of the Buxahatchee and neighboring streams, is thus determined with a great degree of probability, if not with certainty. I have no doubt but that they are slates of the Coal Measures, or perhaps in some cases, of underlying Sub-Carboniferous age. The close proximity of an area of metamorphic action, may serve to account for the toughness and fissile character of these slates, which have probably been themselves partially metamorphosed.

Economic Materials.—Some of the impure limestone beds of the Sub-Carboniferous group, have been tested as to their fitness as material for hydraulic lime, and in the case of the limestone occurring near Siluria, it has been found to answer. Satisfactory tests on a large scale have not yet been made.

LIMONITE.—Beds of brown iron ore or limonite, have been noticed as occurring frequently upon the ridges of chert of the Sub-Carboniferous group; but so far as the analyses go the ore is worthless. In the first place it is not likely to occur in any considerable quantity, then it is too frequently largely contaminated with chert, which often has the appearance of chalk (being white and pulverulent), but the gritty feel when it is rubbed between the fingers or between the teeth, will betray it: and lastly, the per centage of phosphorus is generally unusually large. In one specimen which was analyzed by me, it reached the figure of 4 per cent., equivalent to 9 per cent. of Phosphoric acid. Other samples gave 1.9 and 2.5 per cent. Phosphorus.

Unless, therefore, the ore has been analyzed and proven to be good, a purchase would be, to say the least, a risk.

COAL.—Of the quantity or amount of the coal contained in this part of the Coosa fields, very little can be said as yet. The occurrence of coal in this region has undoubtedly been noticed, but no workable beds of it have yet been found.

Under the beds of chert in the lower part of the Sub-Carboniferous formation which lines the Coosa coal field, a bed of black or dark blue fissile shales, like many in the coal measures, is constantly found. At the Gap of the Mountain they are well shown in contact with the overlying chert beds. The thickness of the bed is not less than ten feet. Underneath a similar bed, perhaps the same, at Mr. Thompson's house at Calera, is found a dark blue argillaceous limestone.

SUMMARY OF CHEMICAL ANALYSES.

The appended summary, in tabular form, of the chemical analyses appearing in the body of the report, will be found convenient for reference.

The analyses are from various, but always trustworthy sources.

Table I. Iron Ores.

BROWN ORES, OR LIMONITES.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No, 6.	No. 7.
Water..................	......	12.51	13.09	8.55	11.35	12.14	11.55
Insoluble, Silica, &c.....	9.80	3.28	3.10	34.03	2.46	12.16	2.98
Sesquioxide of Iron.....	......	83.89	84.25	57.46	84.46	75.04	82.83
Sulphur................	none.	......	......	......	0.14	0.14	0.14
Phosphoric Acid........	0.31	trace.	trace.	trace.	0.58	0.00	trace.
Alumina	3.75	......	......	. ....	0.91	0.30	1.39
Manganese..............	none.	......	......	......	0.33	0.00	1.02
Metallic Iron.......	50.68	58.75	59.00	40.24	59.15	52.55	58.01
Phosphorus.........	0.12	trace.	trace.	trace.	0.25	none.	trace.

No. 1. Brown ore from head of Caffee's Branch. Analyzed by Dr. T. M. Drown.

No. 2. Brown Ore, from Edward's Bank, near Greenpond. Analyzed by Prof. Roepper.

No. 3. Brown Ore, from another part of same property as No. 2. Same analyst.

No. 4. Brown Ore, locality same as Nos. 2 and 3. Same analyst.

No. 5. Brown Ore, near Woodstock Station, Tuscaloosa county. Analyst, Prof. N. T. Lupton.

No. 6. Brown Ore, near Woodstock Station, Tuscaloosa county. Same analyst.

No. 7. Brown Ore, near Woodstock Station, Tuscaloosa county. Same analyst.

Table II. Iron Ores.

RED HEMATITES.

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No.10
Water	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.60
Silica, &c	16.31	31.62	32.04	31.83	31.16	31.91	16.73	17.38	10.39	18.60
Alumina	3.76	4.14	5.13	4.46	4.64	4.05	2.01	6.06	5.37	5.25
Sesquioxide of Iron	78.55	62.45	59.97	60.51	59.87	60.32	66.84	.....	.....	71.93
Lime	0.68	1.03	.....	.....	.....	.....	.....	.....	.....	.....
Carbonate of Lime	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.86
Magnesia	0.21	0.34	.....	.....	.....	.....	.....	.....	.....	.....
Phosphoric Acid	0.49	0.42	0.45	0.45	0.43	0.45	0.38	.....	.....	0.32
Sulphur	trace	.....	.....	.....	.....	.....	.....	none	0.08	.....
Metallic Iron	54.98	43.71	41.98	42.36	41.91	42.22	46.79	50.82	55.51	50.35
Phosphorus	.....	.....	.....	.....	.....	.....	.....	0.09	0.06	0.28

Nos. 1 to 7 inclusive, are Red ores from seven distinct beds of ore worked at the Eureka Company's Mine, near Birmingham. Analyst, Dr. Otto Wuth, of Pittsburgh.

No. 8. Red ore from the western side of the valley, near Tannehill. Analyst, Mr. J. B. Britton, of Philadelphia.

No. 9. Red ore from near the locality of No. 8. Analyst, Dr. T. M. Drown, of Easton, Pa.

No. 10. Red ore from S. 19, T. 20, R. 5, west, western side of the valley, near Greenpond. Analyst, Mr. A. W. Kinzie.

Table III. Limestones.

	No. 1.	No. 2.
Water	0.11	0.10
Organic Matter	0.07	0.06
Silicic Acid	2.13	5.32
Alumina	0.21	0.71
Sesquioxide of Iron	0.12	0.08
Carbonate of Lime	90.60	93.40
Carbonate of Magnesia	6.74	0.32
Phosphoric Acid	0.016	0.011

No. 1. Trenton Limestone, near Eureka mines, six miles from Birmingham. Analyst, Dr. Otto Wuth.

No. 2. Sub-Carboniferous Limestone, near Eureka Mines. Analyst, Dr. Otto Wuth.

FAUNA OF ALABAMA.

FRESH WATER AND LAND SHELLS.

There is no State in the Union that affords a more diversified Molluscan Fauna than is found within the limits of Alabama. While exhibiting no marked superiority in the number of species that are classed as Land Shells, and possibly displaying a meager list of aquatic pulmonates, it is remarkably rich in fresh water bivalves (Unionidæ), and in an operculate class of aquatic univalves, chiefly of the family Melanidæ.

The list of species here presented is compiled from various sources, chiefly the writings of Isaac Lea, L. L. D., who has written more on the fresh water shells of North America than all other original writers together. The compilations and writings of Mr. W. G. Binney have afforded much aid in compiling the pulmonate species. The writings of Thomas Say and other distinguished American Conchologists, have also been consulted.

The verification of facts relative to local and geographical distribution, has been greatly aided by material presented by various gentlemen, who have, at different times, collected shells in various parts of Alabama. Among the gentlemen to whom the greatest credit is due for specimens and notes on Geographical Distribution, may be mentioned Dr. E. R. Showalter, of Mobile, formerly of Uniontown, who, prior to 1861, was largely interested in bringing to light many species which were previously unknown. Later, Mr. Truman H. Aldrich, of Montevallo,

formerly of Selma, has taken up the subject and afforded much valuable information. At Tuscumbia, L. B. Thornton, Esq., and Mr. B. Pybas have made many useful discoveries. At Tuscaloosa, Dr. Eugene A. Smith, State Geologist of Alabama, has recently made additions to the subject. There are, no doubt, portions of the State that have not been explored, and very likely unknown species remain to be brought to light. The shells of the Chattahoochee River, and of streams in the eastern part of Alabama were very diligently studied prior to 1861, by Dr. Hugh M. Neisler, Mr. Garrett Hallenbeck and Wm. Gesner, at Columbus, Ga. The late Rt. Rev. Stephen Elliott, of Savannah, Ga., also materially aided in contributions to our knowledge of. the shells of Alabama, Georgia and other Southern States. A study of the shells of Alabama necessarily involves a portion of the fauna of Georgia and other States on the borders of Alabama. To isolate them in cases in which there is a doubt as to the extent of Geographical Distribution is sometimes difficult. Species may have been credited to Alabama that may hereafter not be verified. Unquestionably a few species that were referred to Georgia at the time they were described, will hereafter also be found in Alabama, though not so recorded here.

The fascinating character of the study of this branch of Natural History will assuredly bring new collectors into the field, and bring to light many new facts which at some future time will make a revision of the present list necessary.

JAMES LEWIS.

Mohawk, N. Y., October 24th, 1876.

Shell-bearing Mollusca of Alabama.

LAMELLIBRANCHIATA.

CONCHIFERA.

Family Unionidæ.

GENUS UNIO, *Brug.*

U. abacus, *Haldeman*. Tennessee drainage.
" acutissimus, *Lea*. Alabama river; Coosa river.
" Æsopus, *Green*. Tennessee drainage.
" alatus, *Say*. " "
" altilis, *Conrad*. Alabama river.
" amœnus, *Lea*. Tennessee drainage.
" Andersonensis, *Lea*. " "
" Anodontoides, *Lea*. Chattahoochee and Alabama rivers; Bogue Chitto Creek.
" appressus, *Lea*. Tennessee drainage.
" aquilus, *Lea*. Chattahoochee or its tributaries.
" arcæformis, *Lea*. Tennessee drainage.
" arctatus, *Con*. Black Warrior, Coosa and Cahawba rivers.
" arcus, *Con*. Alabama river.
" argenteus, *Lea*. Tennessee drainage.
" asper, *Lea*. Alabama river.
" asperatus, *Lea*. Alabama and Coosa rivers; Cahawba river; Buck creek.
" atro-costatus, *Lea*. Alabama and Coosa rivers; Cahawba river.
" atro-marginatus, *Lea*. Chattahoochee river.

U. basalis, *Lea.* Carter's creek, (Ga.)
" bellulus, *Lea.* Tennessee drainage.
" biemarginatus, *Lea.* " "
" Bigbyensis, *Lea.* " "
" Binneyi, *Lea.* "Alabama." (Lea.)
" Blandianus, *Lea.* Coosa river.
" Boykinianus, *Lea.* Alabama, Chattahoochee and Coosa rivers; Buck creek.
" brevidens, *Lea.* Tennessee drainage.
" Brumbyanus, *Lea.* "Warrior river."
" cælatus, *Conrad.* Tennessee drainage.
" Cahabensis, *Lea.* Cahawba river.
" camelopardilis, *Lea.* Tennessee drainage.
" camelus, *Lea.* " "
" camptodon, *Say.* Coffee creek and Big Prairie creek.
" caperatus, *Lea.* Tennessee drainage.
" capsæformis, *Lea.* " "
" castaneus, *Lea.* Alabama river.
" Chattanoogaensis, *Lea.* Coosa and Cahawba rivers; Bogue Chitto creek.
" Chunii, *Lea.* Near Selma.
" circulus, *Lea.* Tennessee drainage.
" circumactus, *Lea.* Tennessee drainage.
" Claibornensis, *Lea.* Alabama river.
" Clarkianus, *Lea.* Tennessee drainage.
" clavus, *Lamarck.* " "
" Clinchensis, *Lea.* " "
" compactus, *Lea.* Coosa and Cahawba rivers; Buck creek.
" concestator, *Lea.* Chattahoochee river.
" concolor, *Lea.* Big Prairie creek; Buck creek; Cahawba river.
" Conradianus, *Lea.* Tennessee drainage.
" consanguineus, *Lea.* Alabama, Coosa and Cahawba rivers.
" Cooperianus, *Lea.* Tennessee drainage.
" corneus, *Lea.* Chattahoochee tributaries.

U. cornutus, *Barnes*. Alabama, Coosa and Tennessee rivers.
" corvunculus, *Lea*. Cahawba river.
" Columbensis, *Lea*. Chattahoochee river.
" crassidens, *Lamarck*. Alabama, Coosa and Tennessee rivers. Cahawba river.
" crebrivittatus, *Lea*. Coosa river; Coosawattee river.
" crudus, *Lea*. Tennessee Drainage.
" cuneolus, *Lea*. Tennessee Drainage.
" cylindrellus, *Lea*. "Northern Alabama," (Lea).
" cylindricus, *Say*. Tennessee Drainage.
" decisus, *Lea*. "Alabama river," (Lea). Bogue Chitto creek.
" declivis, *Say*. Alabama. Shoal creek.
" decumbens, *Lea*. "Alabama," (Lea).
" denigratus, *Lea*. Chattahoochee river.
" deviatus, *Anthony*. Tennessee Drainage.
" discrepans, *Lea*. "Northern Alabama," (Lea).
" dispar, *Lea*. Chattahoochee river; Bogue Chitto creek.
" dolabelloides, *Lea*. Tennessee Drainage.
" dolosus, *Lea*. Alabama and Cahawba rivers.
" dromas, *Lea*. Tennessee Drainage.
" ebenus, *Lea*.. Alabama river.
" Edgarianus, *Lea*. Tennessee drainage.
" Estabrookianus, *Lea*. Tennessee Drainage.
" excavatus, *Lea*. Alabama, Coosa, Black Warrior, and Cahawba rivers; Buck creek; Bogue Chitto creek.
" exiguus, *Lea*. Chattahoochee river; Shoal creek.
" extensus, *Lea*. Chattahoochee river.
" fabalis, *Lea*. Tennessee Drainage.
" fallax, *Lea*. Chattahoochee river.
" fibuloides, *Lea*. Coosa river (Showalter).
" flavescens, *Lea*. Black Warrior river.
" flavidus, *Lea*. Tennessee Drainage.
" Florentinus, *Lea*. Tenneessee Drainage.
" foliatus, *Hildreth*. Tennessee river.

U. Foremanianus, *Lea*. Coosa and Cahawba rivers; Buck creek.
" Forsheyi, *Lea*. Big Prairie creek.
" fraternus, *Lea*. Chattahoochee river; Cahawba river?
" fucatus, *Lea*. "Northern Alabama," (Lea). Tuscumbia.
" fumatus, *Lea*. Chattahoochee tributaries.
" Gerhardtii, *Lea*. Cahawba river; Buck creek. (Querie, Spillmanii?)
" germanus, *Lea*. Coosa river.
" Gesnerii, *Lea*. Uchee creek.
" gibbosus, *Barnes*. Tennessee river.
" glandaceus, *Lea*. Cahawba river; Buck creek.
" glans, *Lea*. Tennessee drainage.
" Gouldii, *Lea*. "Tuscaloosa," (Lea).
" gracilis, *Barnes*. Tennessee drainage.
" granulatus, *Lea*. Big Prairie creek; Coosa river.
" Greenii, *Conrad*. Black Warrior river.
" Hallenbeckii, *Lea*. Chattahoochee tributaries.
" Hanleyianus, *Lea*. Coosawattee river.
" Hartmanii, *Lea*. Coosa river.
" Haysianus, *Lea*. Tennessee drainage.
" Holstonensis, *Lea*. Tennessee drainage.
" incrassatus, *Lea*. Chattahoochee river.
" inflatus, *Lea*. Alabama river.
" infucatus, *Conrad*. Chattahoochee river.
" instructus, *Lea*. Cahawba river; Buck creek.
" intercedens, *Lea*. Chattahoochee river.
" intermedius, *Conrad*. Tennessee river.
" interventus, *Lea*. Cahawba river.
" irroratus, *Lea*. Tennessee drainage.
" Johannis, *Lea*. Coosa river (Showalter).
" Kleinianus, *Lea*. Chattahoochee river.
" late-costatus, *Lea*. "Tuscaloosa," (Lea).
" Lawii, *Lea*. Tennessee drainage.
" Lesueurianus, *Lea*. Tennessee drainage.
" lens, *Lea*. Tennessee drainage.
" Lewisii, *Lea*. Coosa river.

U. lienosus, *Conrad*. Creeks—Bogue Chitto creek.
" limatulus, *Conrad*. Uchee Bar (Chattahoochee river). (Lea, X 43.)
" ligamentinus, *Lamarck*. Tennessee river.
" lineatus, *Lea*. Chattahoochee river.
" linguæformis, *Lea*. Chattahoochee river.
" litus, *Lea*. Cahawba river; Buck creek; Shoal creek.
" luridus, *Lea*. Coosawattee river.
" medius, *Lea*. Coosa river.
" Meredithii, *Lea*. Spring creek, Tuscumbia. (Thornton.)
" metanever, *Raf*. Alabama, Coosa and Tennessee rivers.
" Mississippensis, *Con*. Coffee creek.
" modicellus, *Lea*. Connesauga river and Chattanooga.
" modicus, *Lea*. Chattahoochee river.
" monodontus, *Say*. Tennessee river.
" Mooresianus, *Lea*. Tennessee river.
" multiradiatus, *Lea*. Tennessee river.
" mundus, *Lea*. Tennessee river.
" Nashvillensis, *Lea*. Beech creek; Shoal creek.
" negatus, *Lea*. Big Prairie creek; Bogue Chitto creek.
" neglectus, *Lea*. "Northern Alabama," (Lea).
" nigellus, *Lea*. Chattahoochee river.
" nucleopsis, *Conrad*. Coosa river (Showalter).
" nux, *Lea*. Alabama river; Buck creek; Cahawba river; Shoal creek.
" obesus, *Lea*. Chattahoochee river.
" obtusus, *Lea*. Chattahoochee river.
" obuncus, *Lea*. Tennessee drainage.
" ornatus, *Lea*. "Alabama"? (Lea).
" ovatus, *Say*. Tennessee river.
" pallescens, *Lea*. "Tuscaloosa," (Lea.)
" pallidofulvus, *Lea*. Cahawba river.
" parvulus, *Lea*. Coosa river.
" parvus, *Barnes*. Tennessee drainage.
" paulus, *Lea*. Chattahoochee river; Beech creek.
" pellucidus, *Lea*. Chattahoochee river.

U. penicillatus, *Lea.* Chattahoochee river.
" penitus, *Conrad.* Alabama river; Coosa river.
" perovatus, *Conrad.* "Green county," (Conrad).
" perovalis, *Conrad.* Alabama river.
" perpastus, *Lea.* Coosa river.
" perpictus, *Lea.* Tennessee drainage.
" perplexus, *Lea.* Tennessee drainage.
" perradiatus, *Lea.* Tennessee river.
" phaseolus, *Hildreth.* Tennessee river.
" placitus, *Lea.* "Alabama," (Lea).
" planeus, *Lea.* Coosa and Cahawba rivers.
" planicostatus, *Lea.* Tennessee drainage.
" planior, *Lea.* Tennessee drainage.
" plenus, *Lea.* Tennessee river; Alabama river.
" porphyrius, *Lea.* Coosa river.
" Postellii, *Lea.* Chattahoochee river.
" Prattii, *Lea.* Chattahoochee river.
" propinquus, *Lea.* Tennessee river.
" pudicus, *Lea.* "N. Alabama," (Lea).
" pullatus, *Lea.* Chattahoochee river.
" pulvinulus, *Lea.* Coosawattee river; Tuscaloosa.
U. purpuratus, *Lamarck.* Alabama river; Coosa river; Bogue Chitto creek.
" pustulosus, *Lea.* Tennessee river.
" Pybasii, *Lea.* Tennessee drainage; small streams; Coosa river; Shoal creek.
" pyramidatus, *Lea.* Tennessee and Alabama rivers; Coosa river (Showalter).
" pyriformis, *Lea.* Chattahoochee river.
" quadratus, *Lea.* Chattahoochee river or tributaries.
" radians, *Lea.* Cahawba river.
" radiosus, *Lea.* Tennessee river.
" Raeensis, *Lea.* Chattahoochee river.
" Rangianus, *Lea.* Tennessee river.
" recurvatus, *Lea.* " "
" Roswellensis, *Lea.* Chattahoochee river.
" rubellinus, *Lea.* Coosa river; Cahawba river; Shoal creek.

U. rubellus, *Con.* Black Warrior river.
" rubidus, *Lea.* Coosa river and Big Prairie creek.
" Rumphianus, *Lea.* Coosa and Cahawba rivers.
" rutilans, *Lea.* Chattahoochee river; Shoal creek.
" salebrosus, *Lea.* Chattahoochee or tributaries.
" saxeus, *Conrad.* Alabama river.
" scitulus, *Lea.* Spring creek, Tuscumbia.
" securis, *Lea.* Tennessee river; Alabama river.
" Showalterii, *Lea.* Coosa river.
" simplex, *Lea.* Black Warrior river.
" simulans, *Lea.* Cahawba river.
" Sloatianus, *Lea.* Chattahoochee river.
" Sowerbyanus, *Lea.* Tennessee river.
" sparsus, *Lea.* " "
" sparus, *Lea.* Shoal Creek.
" sphæricus, *Lea.* Alabama river; Cahawba river.
" stabilis, *Lea.* Coosa river.
" stapes, *Lea.* Tennessee river.
" Stewardsonii, *Lea.* " "
" stramineus, *Conrad.* Uchee and other creeks; Beech creek.
" striatus, *Lea.* Chattahoochee river.
" strigosus, *Lea.* Chattahoochee or tributaries.
" subangulatus, *Lea.* Chattahoochee river; Buck creek; Shoal creek.
" subellipsis, *Lea.* Chattahoochee river; Buck creek; Shoal creek.
" subgibbosus, *Lea.* Coosa river; Alabama river.
" subglobatus, *Lea.* Tennessee river.
" sublatus, *Lea.* Uchee bar; Buck Creek; Cahawba river; Shoal creek.
" sudus, *Lea.* Chattahoochee river.
" Taitianus, *Lea.* "Alabama river."
" tenuissimus, *Lea.* Tennessee river.
" tetralasmus, *Say.* Creeks.
" Thorntonii, *Lea.* Tennessee river.
" tortivus, *Lea.* Chattahoochee river.
" trapezoides, *Lea.* Alabama river.

U. triangularis, *Barnes*. Tennessee river.
" trinacrus, *Lea*. Coosa river.
" Troschelianus, *Lea*. Coosawattee river.
" turgidulus, *Lea*. Florence.
" tuberculatus, *Barnes*. Big Prairie creek; Cahawba river.
" tumescens, *Lea*. Tennessee river.
" Tuscumbiensis, *Lea*. " "
" umbrans, *Lea*. Shoal creek.
" umdulatus, *Barnes*. Tennessee river.
" unicolor, *Lea*. Tuscaloosa.
" vallatus, *Lea*. Bogue Chitto creek; Buck creek; Cahawba river.
" verrucosus, *Barnes*. Tennessee river.
" verus, *Lea*. Cahawba river; Buck creek.
" verutus, *Lea*. Chattahoochee river.
" vibex, *Conrad*. Black Warrior river.
" virescens, *Lea*. Tennessee drainage; Spring creek, Tuscumbia; Beech creek.
" viridans, *Lea*. Chattahoochee river.
" viridiradiatus, *Lea*. Big Uchee creek.
" zig zag, *Lea*. Alabama river. [Querie, donaciformis Lea ?]

Genus MARGARITANA, *Schum*.

M. Alabamensis, *Lea*. Talladega creek (Lea); Buck creek: Beech creek.
" complanata, *Barnes*. Big Prairie creek.
" Connesaugaensis, *Lea*. Head waters of Alabama river.
" Curreyana, *Lea*. Tennessee river.
" Elliottii, *Lea*. Chattahoochee river; Uchee creek.
" Georgiana, *Lea*. Tributaries of Coosa river; Shoal creek.*
" Gesnerii, *Lea*. Uphaupee creek.
" Holstonia, *Lea*. Coosa river (abounds in streams tributary to the Tennessee river); Shoal creek.
" marginata, *Say*. Tennessee river.

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*[NOTE.—Possibly the shell referred to Shoal creek, as Marg. Georgiana may be Holstonia.

M. minor, *Lea*. Tennessee drainage (small streams tributary to Tennessee river.)
" rugosa, *Barnes*. Tennessee river.
" Spillmanii, *Lea*. Cahawba river.
" triangulata, *Lea*. Chattahoochee river.

Genus ANODONTA, *Lamarck*.

A. edentula, *Say*. Tennessee river.
" Gesnerii, *Lea*. Uphaupec creek.
" Hallenbeckii, *Lea*. Uphaupec creek.
" Showalterii, *Lea*. Coosa river ; Big Prairie creek.
" subvexa, *Conrad*. Black Warrior river.

Family CORBICULADÆ.

Genus CYRENA, *Lamarck*.

C. Carolinensis, *Lamarck*. Mobile bay.

Genus SPHÆRIUM, *Scopoli*.

S. stramineum, *Conrad*.
S. fabale, *Prime*. Shoal creek.
S. occidentale, *Prime*. (Near Columbus, Ga.)
S. contractum, *Prime*. Grier's creek.

Genus PISIDIUM, *Pfeiffer*.

P. Virginicum, *Bourguignat*. Chattahoochee river.
P. abditum, *Haldeman*. Springs and small streams.

PECTINIBRANCHIATA.

Family MELANIDÆ.

Sub-Family STREPOMATIDÆ.

Genus STREPOMA, *Raf*.

Sub Genus Io, *Lea*.

Io spinosa, *Lea*. Tennessee river.
Io turrita, *Anthony*. Bridgeport. Tennessee river.

Sub Genus ANGITREMA, *Haldeman*.

A. angulata, *Wetherby*. Elk river. Compare *Wheatleyi* Tryon.

A. armigera, *Say*. Tennessee river.
" curta, *Lea*. Tennessee river.
" lima, *Con*. Elk river. (Compare verrucosa, *Raf*.)
" salebrosa, *Con*. Tennessee river.
" subglobosa, *Lea*. Tennessee river.
" Tuomeyi, *Lea*. Tennessee river.
" verrucosa, *Raf*. Tennessee river.
" Wheatleyi, *Tryon*. Elk river.

Sub-genus Lithasia, *Haldeman*.

L. brevis, *Lea*. Alabama and Coosa rivers.
L. compacta, *Anthony*. Cahawba river; Buck creek.
L. cylindrica, *Lea*. Coosa river.
L. dilatata, *Lea*. Tennessee river.
L. Florentiana, *Lea*. Florence.
L. fusiformis, *Lea*. Coosa river.
L. imperialis, *Lea*. Tuscumbia.
L. purpurea, *Lea*. Cahawba river. (See Gon. purpurea, *Lea*.)
L. Showalterii, *Lea*. Cahawba river; Alabama river.
L. vittata, *Lea*. Coosa and Cahawba rivers.

Sub-genus Strebhobasis, Lea.

S. bitæniata, *Con*. "Black Warrior river."
S. carinata, *Lea*. "Tennessee river."
S. Clarkii, *Lea*. "Tennessee river."
S. cornea, *Lea*. Tennessee river.
S. corpulenta, *Anthony*. Tennessee river.
S. Lyonii, *Lea*. Tennessee river.
S. olivaria, *Lea*. Tennessee river.
S. plena, *Anthony*. Tennessee river.
S. solida,*Lea*. Tennessee river.

Sub-genus Trypanostoma, Lea.

T. abruptum, *Lea*. "Alabama," (Lea).
T. affine, *Lea*. Tennessee river.
T. Alabamense, *Lea*. Tennessee river.
T. alveare, *Conrad*. Tennessee river.
T. annuliferum, *Conrad*. "Black Warrior river."

T. Anthonyi, *Lea.* Black Warrior river, and Yellow Leaf creek.

T. aratum, *Lea.* "N. Alabama," (Lea).

T. attenuatum, *Lea.* Tennnessee river.

T. bicinctum, *Tryon.* Tennessee river.

T. bivittatum, *Lea.* Tennessee river.

T. Brumbyi, *Lea.* Coosa river, and at Huntsville.

T. canaliculatum, *Say.* Tennessee river.

T. canalitium, *Lea.* Yellow Leaf creek, and Coosa river.

T. castaneum, *Lea.* Coosa river.

T. Clarkii, *Lea.* "Florence; Coosa, Cahawba, and Alabama rivers." (See Appendix.)

T. Conradii, *Tryon.* Numerous small streams tributary to the Coosa, Cahawba, and Alabama rivers. (See pyrenellum, *Con.*)

T. curvatum, *Lea.* Tennessee river.

T. Currierianum, *Lea.* Yellow Leaf creek.

T. dux, *Lea.* Tennessee river.

T. excuratum, *Conrad.* Tennessee river.

T. filum, *Lea.* Tennessee river.

T. Florencense, *Lea.* Florence.

T. Foremanii, *Lea.* Coosa river.

T. gradatum, *Anth.* "Alabama."

T. gracile, *Lea.* Coosa and Cahawba rivers.

T. Hartmanii, *Lea.* Coosa and Cahawba rivers. (Compare *prasinatum.*)

T. hastatum, *Anth.* "Alabama."

T. incurvum, *Lea.* Tennessee river.

T. Jayi, *Lea.* Coosa and Cahawba rivers.

T. lativittatum, *Lea.* "Chickasaha river, Alabama," (Lea).

T. ligatum, *Lea.* Tennessee river.

T. Leaii, *Tryon.* Coosa river.

T. lugubre, *Lea.* "Alabama."

T. minor, *Lea.* Tennessee river.

T. modestum, *Lea.* Tennessee river. Tryon, page 101. Obs. IX.170. (See lugubre, *Lea.*)

T. moniliferum, *Lea.* Tennessee river.
T. moriforme, *Lea.* Chattanooga. Tennessee river.
T. nobile, *Lea.* Tennessee R., Jackson Co.
T. nodosum, *Lea.* Tennessee river. "Tuscumbia."
T. olivaceum, *Lea.* Tombigbee river.
T. planogyrum, *Anth.* "Alabama."
T. ponderosum, *Anth.* Tennessee river.
T. opacum. *Anth.* "Alabama."
T. Postellii, *Lea.* Tennessee river.
T. prasinatum, *Con.* "Alabama river;" also, in the Coosa and Cahawba rivers.
T. pumilum, *Lea.* Tennessee river.
T. Pybasii, *Lea.* Tennessee river.
T. pyrenellum, *Con.* Talladega Springs; Cahawba river; Buck creek; Clear creek; Coosa river; Sulphur Spring, six miles west of Jacksonville.
T. robustum, *Lea.* Tennesse river.
T. Showalterii, *Lea.* Cahawba river; Coosa river; Tuscaloosa.
T. spinalis, *Lea.* "Alabama."
T. striatum, *Lea.* Shelby Springs; Florence.
T. Thorntonii, Lea. Tennessee river.
T. tortum, *Lea.* Little Uchee river. (See lugubre, *Lea.*)
T. trivittatum, *Lea.* Tombigbee river.
T. Troostii, *Lea.* Tennessee river.
T. Tuomeyi, *Lea.* Tennessee river.
T. univittatum, *Lea.* Cahawba R. (See prasinatum?)
T. venustum, *Lea.* Big Prairie creek. (See vestitum, *Con.*)
T. vestitum, *Conrad.* Big Prairie creek; Green county; Four Mile creek; Buck creek.
T. Wheatleyi, *Lea.* Coosa river.

Sub-genus Goniobasis, Lea.

G. abscida, *Anth.* "Alabama." [Abnormal, old and exeroded.]
G. acuta, *Lea.* N. Alabama. Tributaries of Tennessee river?
G. æqua, *Lea.* Yellow Leaf creek.

G. Alabamensis, *Lea.* Coosa river.
G. ambusta, *Anth.* Cahawba river. "Alabama."
G. amœna, *Lea.* "N. Alabama."
G. ampla, *Lea.* *Anth.* Cahawba and Coosa rivers.
G. angulata, *Anth.* Cahawba river. [var. cinnamomea?]
G. arctata, *Lea.* Tuscaloosa.
G. auricoma, *Lea.* Tennessee river. (Querie instabilis?)
G. auriculæformis, *Lea.* "Tuscaloosa."
G. baculoides, *Lea.* Coosa river.
G. basalis, *Lea.* "Alabama." (Querie, young of *ampla*?)
G. bellùla, *Lea.* Yellow Leaf creek; Cahawba river; Coosa river. (Querie, *Lewisii*, var?)
G. Bentoniensis, *Lea.* Benton Co.
G. Binneyana, *Lea.* Coosa river.
G. Boykiniana, *Lea.* Chattahoochee river.
G. Bridgesiana, *Lea.* Cahawba river.
G. Brumbyi, *Lea.* "Alabama."
G. brunnea, *Anth.* "Alabama."
G. bullula, *Lea.* Yellow Leaf creek.
G. Cahawbensis, *Lea.* Cahawba river; Montevallo.
G. calculoides, *Lea.* Coosa river.
G. capillaris, *Lea.* Coosa river.
G. carinifera, *Lamarck,* Montevallo; Clear creek; Blount spring; Gadsden; Jefferson county; Sulphur spring, 6 miles west of Jacksonville.
G. carino-costata, *Lea.* Montevallo; Talladega spring; Talladega; Buck creek; Calera; Shelby springs; Camp branch; Bowie's spring, 6 miles west of Talladega; Cahatchee.
G. casta, *Anth.* "Alabama."
G. catenoides, *Lea.* Chattahoochee river.
G. cinnamomea, *Anth.* Cahawba river; Buck creek.
G. circincta, *Lea.* Elk river; (querie, banded *plicatula*?)
G. clara, *Anth.* "Alabama."
G. Clarkii, *Lea.* Gravelly springs.
G. clathrata, *Lea.* Jackson county; (very like *arachnoidea*, which is probably a synon. of *acuta*.)

G. clausa, *Lea.* Coosa river.

G. clavæformis, *Lea.* Talladega spring; properly belonging to tributaries of Tennessee river.

G. clavula, *Lea.* Jackson county.

G. cochliaris, *Lea.* Shelby county; [querie, *macella*?]

G. comma, *Con.* "Tributaries of Black Warrior river."

G. continens, *Lea.* Spring creek, Tuscumbia; Buxahatchee creek, near Shelby springs; [querie, Pybasii, without bands?]

G. Coosaensis, *Lea.* Coosa river.

G. corneola, *Anth.* Coosa river; "Alabama;" [young of Lith. brevis?]

G. costulata, *Lea.* Jacksonville, Calhoun county; Sulphur spring.

G. crenatella, *Lea.* "Coosa river."

G. crispa, *Lea.* Florence.

G. cristata, *Anth.* Cahawba river; "Alabama;" *Anth.*

G. crebristriata, *Lea.* Tuscaloosa.

G. crepera, *Lea.* Yellow Leaf creek.

G. cruda, *Lea.* "Tennessee river."

G. culta, *Lea.* Cahatchee creek; Coosa river.

G. cylindracea, *Con.* Black Warrior river; "Tombigbee river."

G. DeCampii, *Lea.* Huntsville.

G. Dooleyensis, *Lea.* "Chattanooga;" (Lea's label.)

G. Elliottii, *Lea.* Little Uchee and Uchee river.

G. ellipsoides, *Lea.* Coosa river.

G. elliptica, *Lea.* Coosa river.

G. excavata, *Anthony.* Cahawba river; "Alabama;" *Anth.*

G. expansa, *Lea.* "Alabama;" Bowie's spring branch, 6 miles north of Talladega; (no figure extant); the apex of the young shell is plicate.

G. fabalis, *Lea.* "Tennessee river;" [querie, Coosa river?]

G. fallax, *Lea.* "Coosa river."

G. fascinans, *Lea.* "Yellow Leaf creek;" Cahawba river; Coosa river.

G. flava, *Lea.* "Benton co.;" Talladega county; Calera, Shelby county.

G. flavescens, *Lea.* Tennessee river; querie, erroneous locality?

G. formosa, *Conrad.* "N. Alabama."

G. fraterna, *Lea.* Bibb county and Cahawba river; [compare pulcherrima, *Anth.*]

G. fumea, *Lea.* Yellow Leaf creek.

G. furva, *Lea.* "Branch of Coosa river."

G. fuscocincta, *Anth.* "Alabama."

G. Gerhardtii, *Lea.* Montevallo; Coosa river; Turner's spring branch, 6 miles south of Talladega; Talladega.

G. germana, *Anth.* Cahawba river.

G. Gesnerii, *Lea.* Uchee river.

G. glabra, *Lea.* North Alabama; tributaries of Tennessee river.

G. glandaria, *Lea.* Coosa river.

G. Gouldiana, *Lea.* "North Alabama;" XII, 92.

G. grata, *Anth.* Big Prairie creek.

G. gravida, *Anth.* "Alabama."

G. grisea, *Anth.* "Tennessee river;" (doubtful.)

G. Hallenbeckii, *Lea.* Chattahoochee river.

G. harpa, *Lea.* "Tuscaloosa;" Coosa river; Cahawba river.

G. Haysiana, *Lea.* "Alabama;" Coosa river.

G. Hydei, *Conrad.* "Black Warrior River."

G. impressa, *Lea.* Coosa river.

G. inclinans, *Lea.* Tuscumbia.

G. inflata, *Haldeman.* Alabama river; (querie, *germana*?)

G. infuscata, *Lea.* Montevallo; "Coosa river."

G. inosculata, *Lea.* Little Uchee river.

G. intercedens, *Lea.* Montevallo; four mile creek; Bogue Chitto creek; Cahawba river; Little Mayberry creek.

G. interrupta, *Haldeman.* Buxahatchee creek.

G. interveniens, *Lea.* "North Alabama."

G. laeta, *Jay.* Coosa river; (querie, *læta*?)

G. lævigata, *Lea.* Alabama river; Talladega springs.

G. Lewisii, *Lea.* "Coosa and Tallapoosa rivers."

G. lita, *Lea.* Cahawba and Coosa rivers.

G. luteola, *Lea.* Coosa river; "Alabama river;" (querie, young *Lith. brevis*?)

G. macella, *Lea.* "Coosa river;" spring at Montevallo; (Coosa river doubtful.)

G. mellea, *Lea.* Coosa river; (querie, *ampla*, half grown?)

G. nassula, *Con.* "Limestone spring at Tuscumbia."

G. negata, *Lea.* Coosa river.

G. obesa, *Anthony.* "Alabama."

G. oliva, *Lea.* "Alabama."

G. olivula, *Conrad.* "Alabama."

G. osculata, *Lea.* Coosa river.

G. ovalis, *Lea.* "Alabama;" Coosa river.

G. paula, *Lea.* Cahawba river; (see *fraterna,* Lea; subangulata, *Anth.*; *pulcherrima, Anth.*)

G. paupercula, *Lea.* "North Alabama."

G. pergrata, *Lea.* Coosa river.

G. perstriata, *Lea.* "Huntsville" and "Coosa river;" compare, *acuta,* Lea, and *carino-costata,* Lea.

G. porrecta, *Lea.* North Alabama; (essentially a Tennessee species found in creeks.)

G. procissa, *Anth.* "Alabama;" (Tryon doubts the local reference.)

G. propria, *Lea.* "Alabama;" (Coosa river?)

G. proxima, *Say.* Alabama; (see Tryon's Strepomatidæ.)

G. pudica, *Lea.* Alabama river; Coosa river; Yellow Leaf creek.

G. pulcherrima, *Anth.* Bibb county; [see paula, *Lea*; subangulata, *Anth;* fraterna, *Lea.*]

G. punicea, *Lea.* Alabama and Coosa rivers.

G. purpurea, *Lea.* Cahawba river; (Tryon says *rara*?)

G. pupæformis, *Lea.* Coosa river.

G. pupoidea, *Lea.* "Alabama;" Alabama, Coosa and Cahawba rivers.

G. Pybasii, *Lea.* Tuscumbia; Spring creek; (compare continens, *Lea.*)

G. quadricincta, *Lea.* Coosa and Cahawba rivers; Talladega county; Montevallo.
G. quadrivittata, *Lea.* Coosa and Cahawba rivers; Montevallo.
G. rara, *Lea.* Coosa and Cahawba rivers.
G. rhombica, *Anth.* "Alabama;" Cahawba river.
G. rubicunda, *Lea.* Coosa river.
G. semicostata, *Con.* Streams in North Alabama.
G. semiquadrata, *Reeve.* "Alabama;" (*quadrivittata* or *gerhardtii.*)
G. Shelbyensis, *Lea.* Yellow Leaf creek.
G. Showalterii, *Lea.* Coosa river; Cahawba river.
G. simplex, *Lea.* "Alabama;" (*Gon. virens, Anth.*)
G. Smithsoniana, *Lea.* Montevallo; Gadsden; Cave creek; Talladega springs.
G. solidula, *Lea.* Yellow Leaf creek.
G. Spillmanii, *Lea.* "Tennessee river."
G. straminea, *Lea.* "Coosa river;" (querie, young of *Lith. brevis?*)
G. strenua, *Lea.* Benton county; Buck creek; Beech creek.
G. subangulata, *Anth.* "Alabama;" Nix's marble quarry, Syllacoga, Talladega county; Bibb county.
G. sulcata, *Lea.* Cahawba river.
G. symmetrica, *Hald.* "Alabama;" Daley's creek; (Gon. imbricata, *Anth.*)
G. Taitiana, *Lea.* Alabama river; Claiborn; Averitt's spring branch, s. e. part of Talladega county.
G. tenebrovittata, *Lea.* Shelby county; "Coosa river."
G. tenera, *Anth.* "Alabama."
G. Thorntonii, *Lea.* Tuscumbia and Florence.
G. trochiformis, *Conrad.* Streams in North Alabama; (querie, Try. filum, *Lea?*)
G. Tuomeyi, *Lea.* "No. Alabama."
G. Ucheensis, *Lea.* Little Uchee river.
G. Vanuxemiana, *Lea.* Alabama and Coosa rivers.
G. varians, *Lea.* Coosa river.
G. variata, *Lea.* Montevallo; Coosa and Cahawba rivers; Buck creek.

G. Vauxiana, *Lea.* "Coosa river."

G. venusta, *Lea.* Coosa river.

G. versa, *Lea.* "Yellow Leaf creek." Lily Shoals, Cahawba river.

G. vesicula, *Lea.* Black Warrior river. (Querie, young of Gon. cylindracea, *Con.?*)

G. vicina, *Anth.* "Alabama."

G. violacea, *Lewis* [MSS.] Rail Road Spring, six miles west of Jacksonville.

G. virens, *Lea.* "Alabama."

G. virgulata, *Lea.* Coosa river; Tallapoosa R. (Querie, young of G. ampla, *Anth.?*)

G. vittata, *Anth.* "Alabama."

G. Wheatleyi, *Lea.* Coosa river.

Sub-genus EURYCÆLON, *Lea.*

E. Anthonyi, *Redfield.* Tennessee river, Bridgeport.

E. crassa, *Haldeman.* Tennessee river.

E. gibberosa, *Lea.* Alabama river.

E. gratiosa, *Lea.* "Coosa river;" Alabama river.

E. lachryma, *Anth.*

E. lepida, *Lea.* "Yellow Leaf creek;" Alabama river, at Selma.

E. midas, *Lea.* Alabama and Coosa rivers. (Alabama river doubtful.)

E. nubila, *Lea.* Coosa river.

E. proteus, *Lea.* "Tuscaloosa."

Sub-genus SCHIZOSTOMA, *Lea.*

S. Alabamense, *Lea.* "Alabama;" Coosa river.

S. amplum, *Anthony.* Coosa river.

S. Anthonyi, *Reeve.* "Alabama."

S. Babylonicum, *Lea.* "Tuscaloosa."

S. Buddii, Lea. "Tuscaloosa."

S. bulbosum, *Anthony.* Coosa river.

S. cariniferum, *Anthony.* Coosa river.

S. castaneum, *Lea.* Coosa river.

S. constrictum, *Lea.* "Tuscaloosa;" Coosa river.

S. curtum, *Mighels.*

S. cylindraceum, *Mighels*. "Warrior river."
S. demissum. *Anthony*. ——— ?
S. ellipticum, *Anth*. Coosa river.
S. excisum, *Lea*. "Alabama."
S. glandulum, *Lea*. Coosa river.
S. glans, *Lea*. Coosa river.
S. incisum, *Lea*. "Alabama."
S. laciniatum, *Lea*. "Tuscaloosa."
S. Lewisii, *Lea*. Coosa river.
S. nuculum, *Anth*. Coosa river.
S. ovoideum, *Shuttleworth*. ——— ?
S. pagoda, *Lea*. "Tuscaloosa;" Coosa river.
S. pumilum, *Lea*. "Alabama;" Coosa river.
S. pyramidatum, *Shuttleworth*. ——— ?
S. salebrosum, *Anth*. Coosa river.
S. Showalteriana, *Lea*. Coosa river.
S. sphæricum, *Anth*. Coosa river.
S. Wetumpkaense, *Lea*. Coosa river. [Querie, var. or young of pagoda?]
S. Wheatleyi, *Lea*. Coosa river.

Sub-genus ANCULOSA, *Say*.

A. ampla, *Anthony*. Cahawba river; Coosa river; Buck creek; Shoal creek.*
A. contorta, *Lea*. Coosa river. [Querie, Lith. compacta, *Anth*.]
A. Coosaensis, *Lea*. Coosa river.
A. Downiei, *Lea*. Coosa river. (Also found in Georgia.)
A. ligata, *Anth*. Tennessee river.
A. melanoides, *Con*. "N. Alabama."
A. picta, *Con*. Alabama, Coosa and Cahawba rivers,
A. plicata, *Con*. Black Warrior river.
A. prærosa, *Say*. Tennessee river. [Varieties are numerous.]
A. rubiginosa, *Lea*. "Warrior river;" Coosa river.
A. Showalterii, *Lea*. Coosa river.
A. squalida, *Lea*. "Tuscaloosa."

* In creeks a small, black variety is found.

A. sub-globosa, *Say*. Tennessee river.

A. tæniata, *Con*. "Alabama river;" Coosa river.

A. tintinnabulum, *Lea*. Tennessee river.

A. virgata, *Lea*. Tennessee river. (—trilineata, *Say*, var.)

A. vittata, *Lea*. Cahawba river. [This has been elsewhere erroneously credited to the Coosa river.]

A. zebra, *Anth*. "Alabama." Coosa and Cahawba rivers.

Family VIVIPARIDÆ.

Genus VIVIPARA.

Sub-genus VIVIPARA.

V. contectoides, *W. G. Binney*. Tuscumbia.

Sub-genus TULOTOMA, *Haldeman*.

T. angulata, *Lea*. Coosa river.

T. bimonilifera, *Lea*. Alabama and Coosa rivers.

T. Coosaensis, *Lea*. Coosa river.

Sub-genus MELANTHO, *Bowditch*.

M. ponderosus, *Say*. Tennessee river. "All parts of the State." (*Aldrich*.)

M. ponderosus, *Say*. var. Nolani, *Tryon*. Coosa, Cahawba and Alabama rivers.

M. ponderosus, *Say*. (geniculate var.) Talladega creek.

M. ponderosus, *Say*. var. coarctatus, *Lea*. Coosa river.

M. ponderosus, *Say*. var. incrassatus, *Lea*. Coosa river.

M. decisus, *Say*. (geniculate var.) Talladega Creek.

M. decisus, *Say*. (coarctate var.) Big Prairie creek.

M. De Campi. *W. G. Binney*. Stevenson.

M. rufus, *Haldeman*. (geniculati var.) Talladega creek.

M. lima, *Anthony*. Huntsville.

Sub-genus LIOPLAX. *Troschel*.

L. subcarinata, *Say*. Chattahoochee river; Coosa river?

L. cyclostomatiformis, *Lea*. Coosa and Cahawba rivers; Black Warrior river.

Family RISSOIDÆ.

Genus SOMATOGYRUS. *Gill.*

S. subglobosus, *Say*. Coosa river? Alabama river.

S. Currierianus, *Lea*. "Huntsville." Decatur.

S. parvulus, *Tryon*. Tennessee river at Bridgeport; Coosa river.

S. aureus. *Tryon*. Tennessee river; Cahawba river; Alabama river; Coosa river.

Genus POMATIOPSIS. *Tryon*.

P. lapidaria, *Say*.

Family NERITIDÆ.

Genus NERITELLA. *Humphrey*.

N. reclivata, *Say*. Mobile Bay? (var. *Floridana*, Shuttleworth.

N. Showalterii, *Lea*. Coosa river.*

Family HELCINIDÆ.

Genus HELICINA, *Lamarck*.

Sub-genus OLIGYRA, *Say*.

O. orbiculata, *Say*. Motevallo.

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*No specimens with opercles are known. It is therefore yet uncertain if this species be a *Neritella*.

PULMONATA LIMNOPHILA.

Family AURICULIDÆ.

Sub-Family AURICULINÆ.

Genus CARYCHIUM, *Muller*.

C. exiguum, *Say*. In moist, shaded stations.

Sub-Family MELAMPINÆ.

Genus MELAMPUS, *Montfort*.

M. bidentatus *Say*. Coast marshes.

Family LIMNÆIDÆ.

Sub-Family LIMNÆINÆ.

Genus LIMNÆA, *Lamarck*.

Sub-genus RADIX, *Montfort*.

R. columella, *Say*. Ponds and streams; near Selma.

Sub-genus LIMNOPHYSA, *Fitz*.

L. desidiosa, *Say*. Small streams and swamps.
L. caperata, *Say*. " " "
L. humilis, *Say*. " " " near Selma.

Genus PHYSA, *Draparnaud*.

P. gyrina, *Say*. Streams and springs.
P. elliptica, *Lea*. Streams and springs. P. oleacea, *Tryon*. Bridgeport.
P. crocata, *Lea*. Streams and springs.
P. Showalterii, *Lea*. Stream from Artesian well, Uniontown.
P. anatina, *Lea*. Streams.
P. Whitei, *Lea*. Streams in Georgia and Alabama.
P. pomilia, *Conrad*. "Randon's creek, near Claiborn."

Genus BULINUS, *Adanson*.

B. hypnorum, *Drap*. Swampy stations.

Genus PLANORBIS, *Guettard*.

P. glabratus, *Say*.

Sub-genus HELISOMA, *Swainson.*

H. bicarinata, *Say.* Ponds and streams. Beech creek; Cahawba river.

H. trivolvis, *Say.* Ponds and streams.

Sub-genus GYRAULUS, *Agassiz.*

G. dilatatus, *Gould.* (Has been found in N. W. Georgia.)

G. parvus, *Say.* Stagnant water and small streams.

Genus SEGMENTINA, *Fleming.*

Sub-genus PLANORBULA, *Haldeman.*

P. Wheatleyi, *Lea.* Swamp near Selma. (Aldrich.)

Sub-family ANCYLINÆ.

Genus ANCYLUS, *Geoffroy.*

A. diaphanus, *Hald.* Tennessee river.

A. ——? Coosa and Cahawba rivers.

Genus ACROLOXUS, *Beck.*

A. filosus, *Conrad.* Black Warrior river, south of Blount Springs; Coosa river?

PULMONATA GEOPHILA.

Family OLEACINIDÆ.

Genus GLANDINA, *Schum.*

G. truncata, *Gmelin.* Vicinity of the Gulf Coast.

Family HELICIDÆ.

Sub-family VITRININÆ.

Genus MACROCYCLIS, *Beck.*

M. concava, *Say.* Wooded districts.

Genus ZONITES, *Montfort.*

Sub-genus OMPHALINA, *Raf.* [Includes Hyalina, *Gray.*]

O. capnodes, *W. G. Binney.* Montevallo.

O. friabilis, *W. G. Binney.*

O. lævigata, *Pfeiffer*. Near Selma.
O. sculptilis, *Bland*.
O. Elliotti, *Redfield*.
O. arboreus, *Say*.
O. viridula, *Menke*.
O. indentata, *Say*. Near Selma; Montevallo.
O. minuscula, *Binney*.
O. capsella, *Gould*.

Sub-genus MESOMPHIX, *Raf*.

M. demissa, *Binney*. Near Selma.
M. acerra, *Lewis*.
M. ligera, *Say*. Montevallo.
M. intertexta, *Binney*.

Sub-genus CONULUS, *Moq-Tand*.

C. fulvus, *Drap*. Near Selma; Montevallo.

Sub-genus VENTRIDENS, *W. G. Binnney*.

V. gularis, *Say*.
V. suppressa, *Say*.
V. lasmodon, *Phillips*.
V. interna, *Say*. Montevallo.

Sub-family HELICINÆ.

Genus PATULA, *Hald*.

P. alternata, *Say*. Wooded districts; near Selma.
P. perspectiva, *Say*. . Wooded districts near Selma.
P. striatella, *Anth*. Wooded districts.

Genus HELIX, *Lin*.

Sub-genus HELICODISCUS, *Morse*.

H. lineatus, *Say*. Wooded districts; near Selma.

Sub-genus STROBILA, *Morse*.

S. labyrinthica, *Say*.

Sub-genus POLYGYRA, *Say*.

P. auriformis, *Bland*. Near Selma.
P. espiloca, *Ravenel*. Near Mobile.

P. plicata, *Say*. (Helix Hazardi, *Bland.*)
P. Febigeri, *Bland*. Near Mobile.
P. pustula, *Fer*.
P. pustuloides, *Bland*. Near Selma; Montevallo.
P. leporina, *Gould*.

Sub-genus STENOTRÈMA, *Raf.*

S. spinosa, *Lea*. Near Selma.
S. labrosa, *Bland*.
S. Edgariana, *Lea*.
S. barbigera, *Redfield*.
S. stenotrema, *Fer*.
S. hirsuta, *Say*. Montevallo.
S. maxillata, *Gould*. Near Selma; Montevallo.
S. monodon, *Rackett*.

Sub-genus TRIODOPSIS, *Raf.*

T. palliata, *Say*.
T. obstricta, *Say*.
T. appressa, *Say*. Montevallo.
T. inflecta, *Say*. Near Selma; Montevallo.
T. Rugeli, *Shuttleworth*.
T. tridentata, *Say*.
T. fallax, *Say*.

Sub-genus MESODON, *Raf.*

M. major, *Binney*.
M. albolabris, *Say*.
M. elevata, *Say*.
M. Clarkii, *Lea*.
M. Christyi, *Bland*.
M. exoleta, *Binney*.
M. Wheatleyi, *Bland*.
M. thyroides, *Say*. Near Selma; Montevallo.
M. bucculenta, *Gould*. Near Selma; Montevallo.
M. clausa, *Say*. Near Selma.
M. jejuna, *Say*.
M. Mobiliana, *Lea*.

Sub-genus VALLONIA, *Risso.*

V. pulchella, *Muller.*

Genus BULIMULUS, *Leach.*

Sub-genus SCUTALUS, *Albers.*

S. dealbatus, *Say.* Northern Alabama ; near Selma.

Genus PUPA, *Drap.*

Sub-genus PUPILLA, *Leach.*

P. pentodon, *Say.*

Sub-genus LEUCOCHILA, *Alb. & Mart.*

L. fallax, *Say.*
L. modica, *Gould.*
L. armifera, *Say.* Common in cane brakes.
L. contracta, *Say.*
L. rupicola, *Say.*
L. corticaria, *Say.*

Genus VERTIGO, *Muller.*

Sub-genus ISTHMIA, *Gray.*

I. Gouldii, *Binney.*
I. ovata, *Say.*
I. ventricosa, *Morse.*
I. milium, *Gould.*

Family SUCCININÆ.

Genus SUCCINEA, *Drap.*

Sub-genus SUCCINEA, *Drap.*

S. luteola, *Gould.*
S. avara, *Say.*
S. obliqua, *Say.*

APPENDIX TO THE UNIONIDÆ OF ALABAMA.

The student who may desire to become acquainted with the Unionidæ of Alabama, will naturally have his attention drawn to some interesting facts relating to Geographical Distribution. In some instances a species will be found to occur in numerous localities, some of them beyond the limits of the State. In other instances, species bearing a very close resemblance to each other occupy stations apart from each other, seldom occurring together. Many species are, so far as is known, limited to a particular stream, or a portion of a system of drainage. Among the species having widest distribution, may be mentioned *Unio Anodontoides*, which occurs in the Chattahoochee and Alabama rivers; and is also found in the Ohio river, and in some of the rivers in Illinois. A group of species very strongly resembling each other, embraces *Unio acutissimus*, *U. parvulus*, *U. rubellinus*, and *U. penicillatus*. The two latter belong also to the State of Georgia. Another group of species strongly resembling each other, varying somewhat in size and other minor details, embraces *Unio striatus*, *U. modicus*, *U. litus*, and *U. striatulus*, the last being found in North Carolina, and later (according to Mr. Lea), in Georgia.

Still another group embraces species, a portion of which are found in adjoining States, as well as in Alabama. Curiously, it appears that some of these species sometimes unquestionably occur in the same station. This group embraces *Unio decisus*, *U. concolor*, *U. consanguineus*, *U. clavus*, *U. pallidofulvus*, *U. interventus*, *U. crebrivittatus*, and *U. Chattanoogaensis*. In the Chattahoochee river, *U. Sloatianus* takes the place of *U. trapezoides*, found in the Alabama

river, and in the rivers of States westward; while on the other hand, *Unio Boykinianus* is found in the Chattahoochee and Alabama rivers, and probably, also, in some of the rivers of Mississippi. *Unio obtusus,* found in the Chattahoochee, also occurs in Mississippi, while a species of similar form, *U. Claibornensis,* takes its place in the Alabama river.

Unio infucatus and *U. Kleinianus* are said to occur in the Chattahoochee river and its tributaries in Georgia, while no available record exists of their having been found in the streams rising in Alabama.

Unio lienosus, found in Mississippi and various streams in Alabama, seems to be replaced in the Chattahoochee system by three well defined species of the same group, viz: *U. concestator, U. intercedens and U. fallax.*

Unio crassidens, a robust species found in Illinois, Ohio, Kentucky, Tennessee, and also in the Alabama and Coosa rivers, in Alabama, is replaced in the Chattahoochee and Flint rivers by a nearly related species—*U. incrassatus.*

Unio camptodon (and *Unio tetralasmus,* possibly a synonym,) occurs in Ohio, as well as in Alabama, Mississippi and Louisiana. *Unio Columbensis,* of the Chattahoochee, seems to unite *camptodon* with *declivis,* forming a group.

Unio atro-costatus, which is often taken to be *U. perplicatus,* Conrad, seems to take the place of that species in Alabama. There is no reliable record that *perplicatus* occurs so far east as Alabama.

Unio Blandianus, of the Othcalooga creek in Georgia, is represented in Alabama by shells which are regarded as being *U. Rumphianus.* If the two should prove to be identical, *Blandianus* will rank as a synonym of *Rumphianus.*

Unio penitus, of the Alabama river, is replaced further east (in Alabama and Georgia) by *U. compactus,* a similar but smaller species. It is possible that both these species occur in the Coosa river; but at the present time a doubt is entertained of such occurrence.

Unio castaneus, of the Alabama river, is the analogue of *U. circulus* of Tennessee and Ohio. Specimens are some-

times seen in collections labeled *circulus*. *Unio unicolor* is probably very similar to *castaneus*.

Unio vallatus, of Bogue Chitto creek, and *U. Cahabensis*, of the Cahawba river, very strongly resemble each other.

Unio Edgarianus, of the Tennessee river and its tributaries, is the type of a group of shells resembling each other in several important particulars. *U. obuncus*, *U. Tuscumbiensis* and *U. Andersonensis* belong to this group.

Among the shells of the Alabama and Coosa rivers are a few which remain to be noted as occurring in Tennessee, Ohio, &c.; *U. metanever*, *U. cornutus*, *U. pyramidatus*, *U. securis*, and possibly *U. plenus*, may be incuded in this list. *Unio tuberculatus*, which occurs in Alabama, is also found in Ohio and adjoining States.

Unio subangulatus, of the Chattahoochee, is represented in Buck creek by a larger shell of the same type, which has not as yet been set apart as a distinct species. It may, however, be regarded as being quite as distinct from *subangulatus* as *medius* is from *striatus* in the Chattahoochee system.

In the Cahawba river three species are indicated, under the names *glandaceus*, *instructus* and *verus*. Specimens evidently referable to the three species have been submitted for examination. They resemble each other very strongly indeed, and differ simply as specimens of different ages and sexes might be supposed to differ, when a single species is subjected to a diversity of conditions.

The student will find that quite a considerable number of species originally quoted as found in various streams in Georgia, have been catalogued as Alabama shells. Among these is *Unio radians*, originally found in the Othcalooga creek in Georgia. Shells from Alabama agreeing very exactly with the description and figure of this species have been submitted for examination. The shells that have been examined are, without doubt, the female forms of an Alabama species called *U. plancus*. The question of the identity of *radians* and *plancus* is still an open one, in the absence of Georgia specimens for comparison.

In the tributaries of the Chattahoochee river occur several species which belong to the "*complanatus group*"—a group which includes a large number of species, of which *Unio complanatus* is a familiar type. This group of shells prevails in the rivers of the Atlantic slope, and very few members of this group occur west of the Chattahoochee drainage. A single instance may possibly present itself in a species known as *Unio sublatus*, specimens of which have been found at or near Montevallo. It is possible, however, that *sublatus* really belongs to a group of which *U. gibbosus* is *almost* the sole type, (*Unio subgibbosus* being the exception.) The specimens referred to have the peculiar dark nacre and the singularly undulated breaks of *U. gibbosus*, though differing from that species in the form of the teeth, and in the details of the muscular and palleal cicatrices.

There remain abundant suggestions which might possibly be profitably added, but as this would necessarily involve much *descriptive matter*, it is deemed expedient to refer the student to the published writings of Isaac Lea, LL. D., in which will be found descriptions of a very large share of the Mollusca of North America, with usually very fine illustrations. The writings of Thomas Say, Mr. T. A. Conrad, Mr. John G. Anthony, Dr. Barnes, Hildreth, and others, might also be read with advantage.

Notes on Corbiculadæ.

Cyrena Carolinensis is found on the Atlantic coast as far North as South Carolina. It occurs also on the west coast of Florida, and has been tabulated here on the presumption that it will unquestionably be found in Mobile Bay.

Shells referable to *Sphærium stramineum*, found in Alabama, are quite unlike any thing from other States that have been presented as that species.

A single specimen, only, of *S. fabale* is all that has been presented from Alabama.

Sphærium occidentale was found prior to 1860 in a swamp near Columbus, Ga.; whether in Alabama or Georgia is unknown. It will undoubtedly be found in similar situations in Alabama.

Pisidium Virginicum is found in numerous rivers in the United States, and undoubtedly will be found in muddy portions of some of the rivers of Alabama.

APPENDIX TO STREPOMATIDÆ.

The Strepomatidæ of Alabama seem to be divided into three great groups. The first is characterized by the presence of the genera *Io* and *Angitrema*, which are locally restricted in this State to the Tennessee Drainage, in which they occur with a preponderating number of species of *Trypanostoma*, a smaller number of species of *Anculosa* and *Strephobasis*, and comparatively a few species of *Goniobasis*.

In the Alabama system of drainage comprising the Tombigbee, Black Warrior, Alabama, Cahawba, and Coosa rivers, and their tributaries, are found a less considerable number of species of *Trypanostoma*, a single species of *Strephobasis*, several species of *Anculosa*, and a preponderating number of species of *Goniobasis*. The characteristic genus of this system of drainage is *Schizostoma*, which includes a considerable number of recognized species. It is believed that this genus is confined to the Coosa river. Doubts, however, are suggested on that point by the fact that several of the earlier species brought to notice were credited to "Tuscaloosa," and the "Warrior river." No recent information on this point affords any means of settling the doubts, though it is hoped that explorations now under contemplation may bring to light conclusive testimony relative to the distribution of *Schizostoma*.

In the Chattahoochee river and its tributaries, have been found only a few species of *Goniobasis*, and possibly a single species of *Trypanostoma*.

In the original descriptions of some of the species of *Trypanostoma*, and *Gonoibasis*, found in the State of Alabama,

localities have been assigned that identify some of the species of the Tennessee system of drainage with certain forms found in the Alabama system. A careful examination of these supposed cases of identity of species in the two systems of drainage has not as yet elicited any confirmatory evidence. It seems, indeed, very probable, that not a single instance of supposed identity will be verified. In explanation, it may be remarked that collectors are *not* always careful to keep apart from each other their unidentified specimens of species from various localities, and it is not an uncommon circumstance for specimens to pass into the hands of the descriptive naturalist with local references of an unreliable character. This, together with the vague and very indefinite mention of the *State* or *Continent* for the *locality* of a species, is surely the source of continual trouble to one who seeks to reconcile his shells with the literature relating to them.

While the preliminary sheets of this paper were in progress, the writer was urgently solicited to embody in it such facts in synonymy as might be thought useful. In reply to these solicitations it may be urged that there is not yet at hand, and may not be for many years to come, a sufficient amount of material to enable the most careful student to do justice to the subject, and not at the same time do injustice to those writers who have done most to define species.

A few of the difficulties of synonomy may be presented in a manner which will be appreciated by those persons who have given the subject slight attention. Take, for instance, some common and well known species of *Trypanostoma,* found in the Tennessee river. On tracing it from point to point along the stream it will be found to vary in several particulars, which are obvious at a glance. If only the *extreme forms* are known, these would appear to the observer to differ so much from each other as to justify him in regarding them as distinct species—an opinion he is compelled to abandon when further investigation has brought to light the intermediate forms. There may be,

and undoubtedly there are species, (as in the family Unionidæ,) in which the sexes are distinguishable from each other by certain peculiarities of form and size. This is a portion of the subject which has not yet been investigated, and really nothing is known relative to it. There are unquestionably instances in which *hybrids* occur. These, except under very favorable conditions for observation, would be likely to be regarded as *species.*

Occasionally abnormal specimens come to the notice of the Naturalist—usually a solitary specimen (and the author "regrets there were not more,") is all that is known, and it is recorded as a species. It sometimes happens that a species produces specimens the epidermis of which exhibits a uniform color without bands. Other specimens, on the other hand, have bands. Unquestionably, a species has been divided and put on record as *two distinct species,* with no better ground for the division than has been stated. Again, a species sometimes produces specimens characterized by several revolving elevated lines or carinæ. Mr. Say made a second species of *Goniobasis Virginica,* based on this peculiarity; Mr. Anthony has bestowed similar attention on a variety of Mr. Say's *Anculosa trilineata;* and a curious sequel to this is that many intelligent naturalists, who do not admit the validity of Mr. Say's "*Melania multilineata,*" regard Mr. Anthony's *Anculosa costata* with favor.

There are yet other perplexities, and these arise out of the diversities of forms a species is liable to manifest when developed under the varying conditions of stations unlike each other in temperature, mineral properties of the water, abundance or absence of appropriate food, the influence of light, the influence of currents in the water, and finally, other influences of equal importance, which possibly have not yet been conjectured.

The *form* of a shell is simply a function of the mantle—a delicate membrane, in which the soft parts within the shell are included, and which lines the interior of the shell and deposits the calcareous matter of which it is composed.

The *color* of a shell may, to a very great extent, depend upon that function of the mantle involved in the production of the epidermis. It may also be to some extent influenced by the properties of the water in which the mollusc lives.

It will be seen that there are numerous conditions which may affect a single species and cause it to be presented under such aspects as to create the impression that different local forms are different species. Much has been done in the direction of synonymy, but without doubt, equally as much more remains to be done. It may also be suggested that a few errors have crept into synonymy, as it is now received, and the work needs revision. In a class of shells embracing so many species, presented under the difficulties that beset the Strepomatidæ, it will be impossible to do more at present than suggest inquiries. The brief hints that occasionally appear in the list of species are all that it seems expedient to suggest at this time.

APPENDIX TO VIVIPARIDÆ.

V. *contectoides* is distributed over a wide extent of territory. It inhabits the rivers of Illinois and Indiana. Specimens from Illinois have been successfully colonized in New York. Very fine specimens of the species are found in Othcalooga Creek, Georgia. A variety of this species occurring in Florida, has received the name V. Waltoni, *Tryon*.

Tulotoma bimonilifera, *Lea*, (magnifica, *Conrad*,) is admitted by the Academy of Natural Sciences to take precedence over *magnifica*. *T. Coosaensis*, hitherto regarded as a true *Vivipara*, is unquestionably a *Tulotoma*, and is well characterized as such by its opercle. Perfect specimens are characterized by numerous short, hairy prolongations of the epidermis on a considerable portion of the surface, and more particularly by a bristly fringe to the margin of the aperture.

Melantho ponderosus, *Say*, which occurs in the Ohio river, and some of its larger tributaries, and attains a large size in some portions of the Tennessee river, has also been found in Mississippi and Georgia, as well as in the rivers of Alabama. Mr. Tryon separates the Alabama shells under the name *M. Nolani*. A number of years ago, Mr. Lea described *Paludina coarctata* and *P. incrassata* from the Coosa river. From a careful comparison of numerous specimens of *Melantho* from the Coosa with shells from other regions and with Mr. Lea's unpublished figure of *coarctata*, it is inferred that *coarctata* and *incrassata* are identical with the shells Mr. Tryon calls *Nolani*. It may seem improbable that a species can exhibit so much variation in form in one locality; but it is apparently an unde-

niable fact, and has a parallel in the two species (?) described by Mr. Anthony as *Pal. subsolida* and *P. exilis*, both referable to the sexual varieties of one species. (In this connection it may be remarked that two specimens of this variable species served as illustrations of the male and female of *Melantho integer* in a work on the shells of North America.) Mr. Lea's *coarctata* is the slender form of the species. His *incrassata* is an immature specimen, the apex of which has been removed by erosion. If the *species* really be distinct from *ponderosus* it should receive the name *coarctata* or *incrassata*, either of which has priority of *Nolani*. A slender variety of *M. decisus* occurring in Big Prairie Creek has been confounded with the Coosa shell that Mr. Lea calls *coarctata*. There are peculiarities of form and color that should forbid the association of the Prairie Creek shell with the Coosa River *coarctata*.

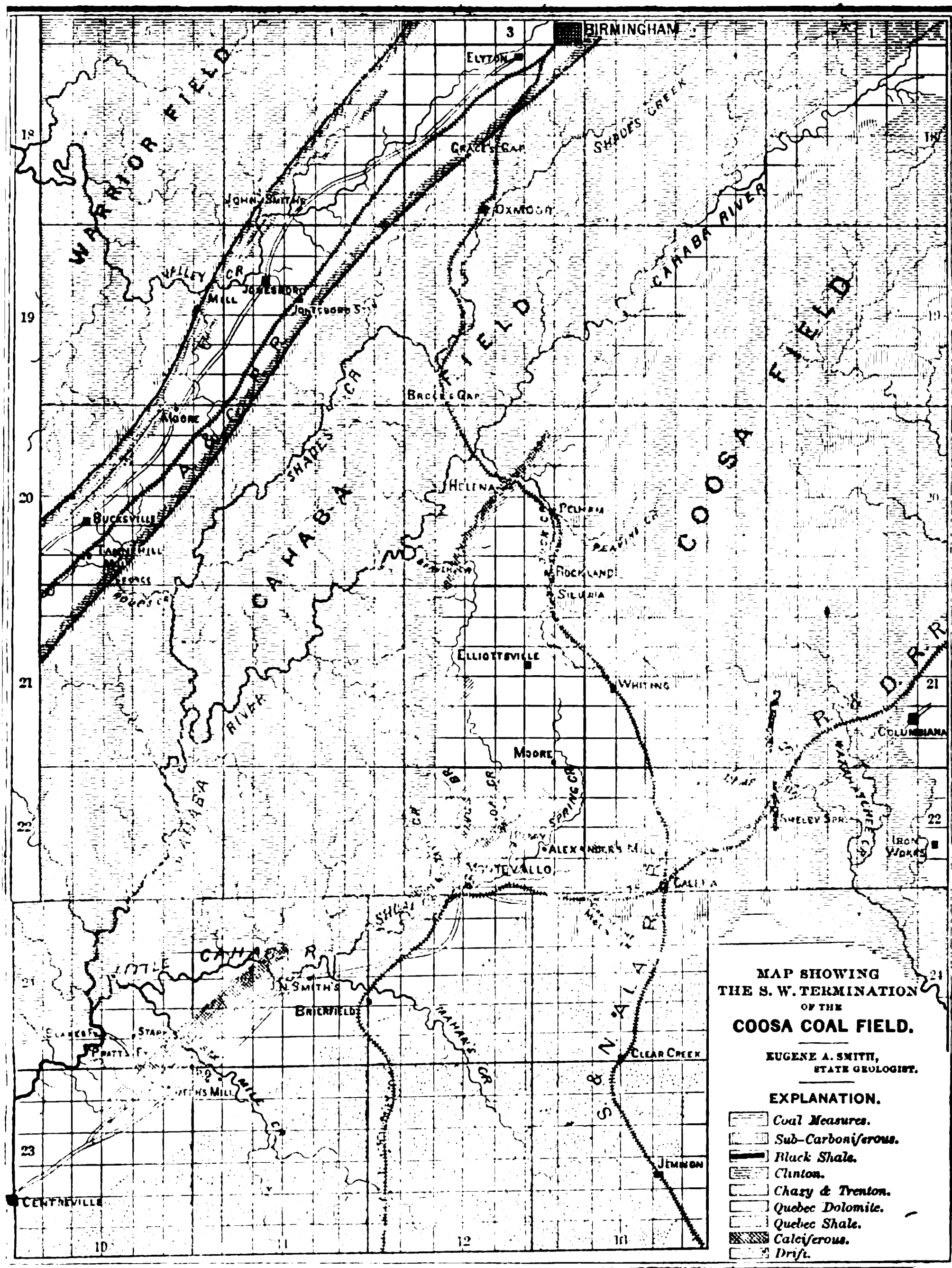
M. decisus, *M. ponderosus* and *M. rufus* occur together in Talladega Creek. They are all in a considerable degree characterized by the shouldered suture which distinguishes Mr. Conrad's *geniculus*.

M. lima, *Anthony*, occurs at Huntsville. It seems to be somewhat nearly related to M. De Campi. *W. G. Binney*. Possibly a full series of specimens might establish their identity.

Specimens doubtfully referable to *Lioplax subcarinata* have been presented as coming from the Coosa river. The specimens referred to have not the peculiar *salmon tinted* upper whorls that characterize *cyclostomatiformis* from the Coosa and Cahawba rivers, and differ in other respects also. It would be interesting to verify the occurrence of both these species in the Coosa river.

APPENDIX TO THE PULMONATA.

The fresh water pulmonates of Alabama seem not to have been thoroughly studied, and there are available no records that locate a considerable number of species which might very reasonably be expected to occur in the State. A large share of these have been omitted from the list—only such species being included as have a local record within the limits of the State or within contiguous portions of adjoining States. The land shells, having been more thoroughly studied, afford sufficient records to make it probable that only a few species likely to occur within the limits of the State have been omitted. It is quite probable that a careful exploration of the mountains in the northern part of the State may bring to light some of the few species that have recently been described as occurring in the not distant mountains of Tennessee and North Carolina. One of these—Mesodon Chilhoweensis, *Lewis*, occurs in northern Georgia, as is established by an immature specimen in the National Museum; and the occurrence of this species in East Tennessee and Georgia would seem to warrant the expectation that it might also be found in Alabama.


MAP SHOWING
THE S. W. TERMINATION
OF THE
COOSA COAL FIELD.
EUGENE A. SMITH,
STATE GEOLOGIST.
EXPLANATION.
Coal Measures.
Sub-Carboniferous.
Black Shale.
Clinton.
Chazy & Trenton.
Quebec Dolomite.
Quebec Shale.
Calciferous.
Drift.
WARRIOR FIELD
CAHABA FIELD
COOSA FIELD
BIRMINGHAM
ELYTON
GRACE'S GAP
SHADES CREEK
OXMOOR
CAHABA RIVER
JOHN SMITH'S
VALLEY CR.
MILL
JONESBORO
MOORE
BUCKSVILLE
BROCK'S GAP
HELENA
PELHAM
PEAVINE CR.
ROCKLAND
SILURIA
ELLIOTTSVILLE
WHITING
COLUMBIANA
S. R. & D. R.R.
SHELBY SPR.
IRON WORKS
SPRING CR.
ALEXANDER'S MILL
MONTEVALLO
CALERA
LITTLE CAHABA R.
J. N. SMITH'S
BRIERFIELD
MAHAN'S CR.
S. & N. ALA. R.R.
CLEAR CREEK
JEMISON
CENTREVILLE

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